Bonsai

B.B.Sharma

BONSAI

Prof. B.B. Sharma

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PREFACE

The need for this book was felt by me when I was a Post Graduate student at Indian Agricultural Research Institute, New Delhi. The raising of bonsai has now been recognized globally as commercially viable. The cultivation of bonsai also creates eco-friendly habits. In view of significant advances in rearing and maintenance of plants in healthy state, I have tried to include scientific information on various aspects of growth of bonsai plants. Chapters on propagation, nutrition, protection, training and pruning and scientific principles of dwarfing have been presented as far as possible in a simple manner.

This book is designed to meet the need of amateurs and professionals alike, engaged in the production of miniature plants.

I wish to express my sincere gratitude to Mr.C.P. Mehra, President, Indian Society of Succulents and Cacti and to Mrs. Aruna Mohan, Chairperson, Y.W.C.A. flower show for numerous photographs on bonsai and for critical suggestions. I am grateful to Mr. Nanak Chand, Senior Photographer, Indian Agricultural Research Institute, New Delhi for his help in taking photographs from various locations and to Mr. Raj Kumar Sharma for typing the manuscript.

I am particularly thankful to Mrs. Surinder Kaur, Director, Publications Division, Ministry of Information and Broadcasting, Government of India who constantly encouraged me in writing' this book.

B.B. Sharma

FOREWORD

Bonsai or miniature trees can be described as living works of art and science. However, they cannot be compared with any other form of art where an artist or a sculptor lays down his brush or tools after completion of his work. Looking after a bonsai is a continuous process. Bonsai inspire an awareness to understand the science and clean enviornment. They motivate us to realize that all of us—man, plant, water, air and nature—are bound together in these laws. Today the art of bonsai is practised all over the world. It is accepted as a means of relaxation as also a good profession.

Dr. B.B. Sharma, former Professor of Horiculture, Indian Agriculture Research Institute, New Delhi and a well known horticulturist desereves to be congratulated in writing a book on this interesting but less read subject. This book provides techniques whereby exact but dwarf replicas of some plants can be prepared in three or four years without the use of stunted plants collected from the wild. This work on bonsai describes in simple language with the help of numerous line illustrations and coloured photographs, the method of planting, potting, manuring, irrigation, general styles and forms.

In view of above, I consider this pulbication a very important addition to our existing literature on ornamental horticulture. I hope the readers of this book will be able to raise bonsai (plants) with great ease and understanding.

Prof. K.L. Chadha
National Professor (Horticulture)
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Horticulture Technology

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INTRODUCTION

The imperfect conditions in nature produce stunted plants. It remains stunted, growing in a small pocket of soil surrounded by stones, thus, providing no chance for the roots to spread. This led to the production of the potted tree which is known today as bonsai. Truly, nature was the first to dwarf the trees. Even the nursery man, many times, leave some plants in pots which remain dwarf, almost of the same size as they were when first planted. In both the cases, the tree does not receive enough nourishment and it is without intention as well.

In principle, the method of dwarfing by supplying conditions similar to those produced by nature, duplicates them in every detail. The container is the main agent that restricts the growth of the plant. Most of the very old bonsai specimens were, in fact, removed from natural sites and shifted to containers. These were gradually perfected in appearance over a period of time.

As a matter of fact, we do not know when the art of bonsai was born. The Buddhists were known to carry plants in pots during their journey in India. The Japanese have pictorial records dating back to about A.D. 1200.

The word 'bonsai' is formed from two words, 'bon' meaning tray or dish and 'sai' meaning tree or plant. Its literal translation is 'tree planted in a dish'. A bonsai, thus, resembles in all aspects its large counterpart in nature.

A bonsai is considered an expression of the harmony between heaven and earth, man and nature. The harmony becomes apparent when it is achieved with the process of balanced growth and development in man as well as in bonsai.

There is a common misconception as to what exactly makes a bonsai. Species of trees are kept in containers over a long period of time. These look like trees of average seedling, consisting of a thick trunk and 2-3 branches coming out often from ungainly angles. Sometimes, they may flower and bear fruits. The ideal bonsai is a tree the size of whose different parts are in proportionate relation to each other. Trunk, branches, twigs and leaves are in harmony, either an exact replica or an artistic variation in shape of the species.

Chinese bonsai experts make a distinction between 'pun-sai' and 'pun-ching'. The word 'pun-jing' means both forms of bonsai. The word 'pun-sai' is made up of the same characters as the Japanese word 'bonsai', meaning a tree planted in pot without any landscape, while 'pun-ching' means a tree planted in a container and landscaped.

An attempt has been made in the following pages to have a glimpse into the world of Bonsai through a number of illustrations and photographs. Various aspects of Bonsai training as also pest and disease management are minutely dealt with. It is expected, the plant lovers and readers in general will find it handy and interesting.

STRUCTURE AND VITAL NEEDS OF A TREE

What makes a tree

A tree has the following important organs

1. The trunk is the most important part of the structure.
2. The main branches are an added character.
3. The laterals in the first, second and third aspects are elements to show grace and beauty
4. The foliage is a gentle frame
5. The roots show the age.

Many shapes

Some basic shapes are as under :

1. The ball 2. The pyramid. 3. The column 4. The broom. 5. The umbrella. (Fig.l)

In addition to these, some more shapes are seen in nature. The shapes in conifers are quite specific. The conical, umbrella and columnar are quite common. But in broad leaved trees, the domed crown, fastigiate, ball and weeping shapes are easily seen.

The possibilities in the variation of shapes are almost endless. The rounded shape can only be indicated by some foliage; the skeleton of trunk and branches is the main attraction. The broom shape can be pleasing when the whole formation is split up on various levels. (Fig.2 Fig. 3 Fig. 4)

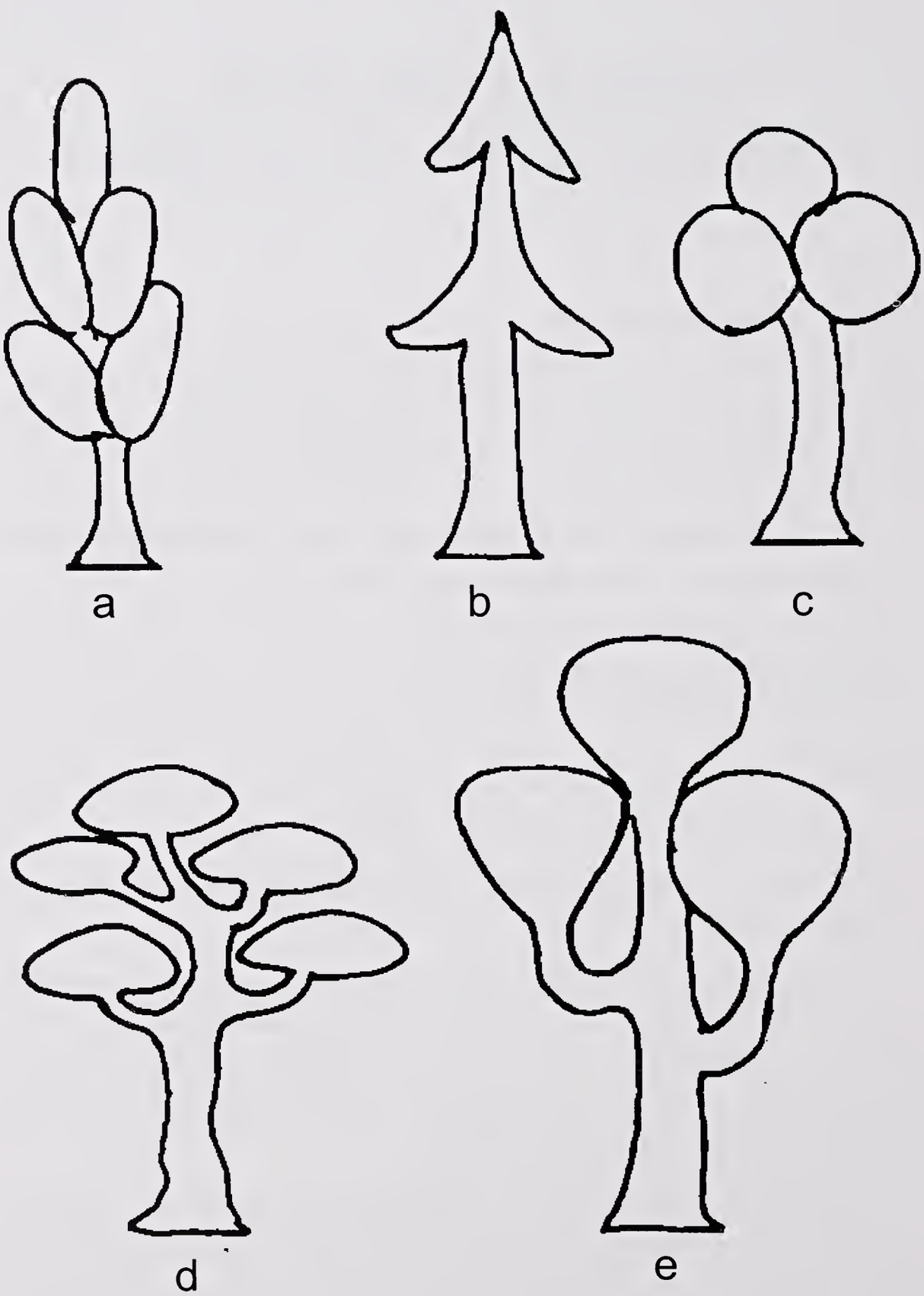


Fig. 1 *Some variation of important shapes* ***(a)*** *the column* ***(b)*** *pyramid* ***(c)*** *the ball* ***(d)*** *the umbrella* ***(e)*** *the broom*

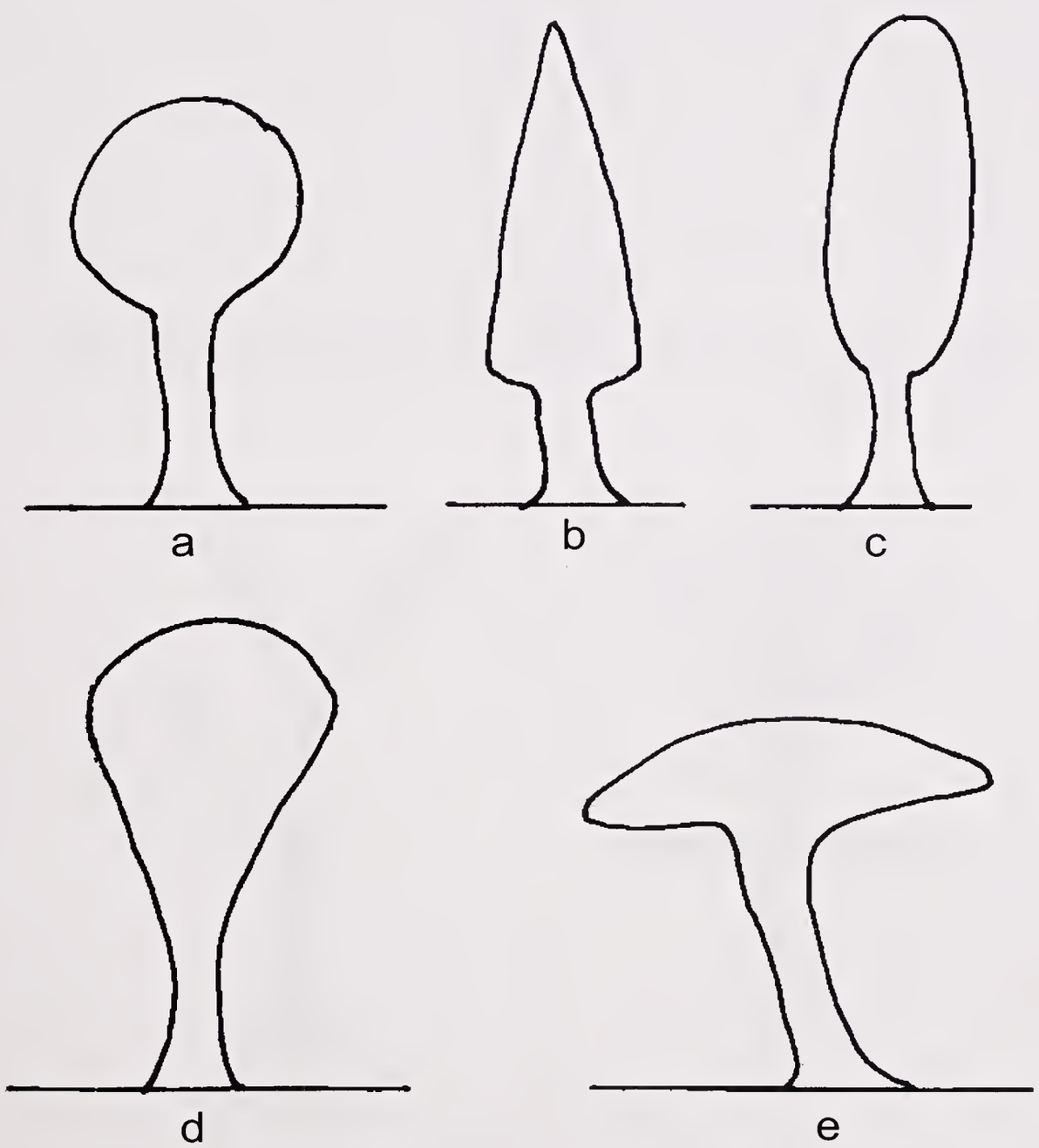


Fig. 2 *Important shapes* ***(a)*** *the ball* ***(b)*** *the pyramid* ***(c)*** *the column* ***(d)*** *the broom* ***(e)*** *the umbrella*

Fig. 3 *Young shoots going straight upward, producing an appreance of a broom*

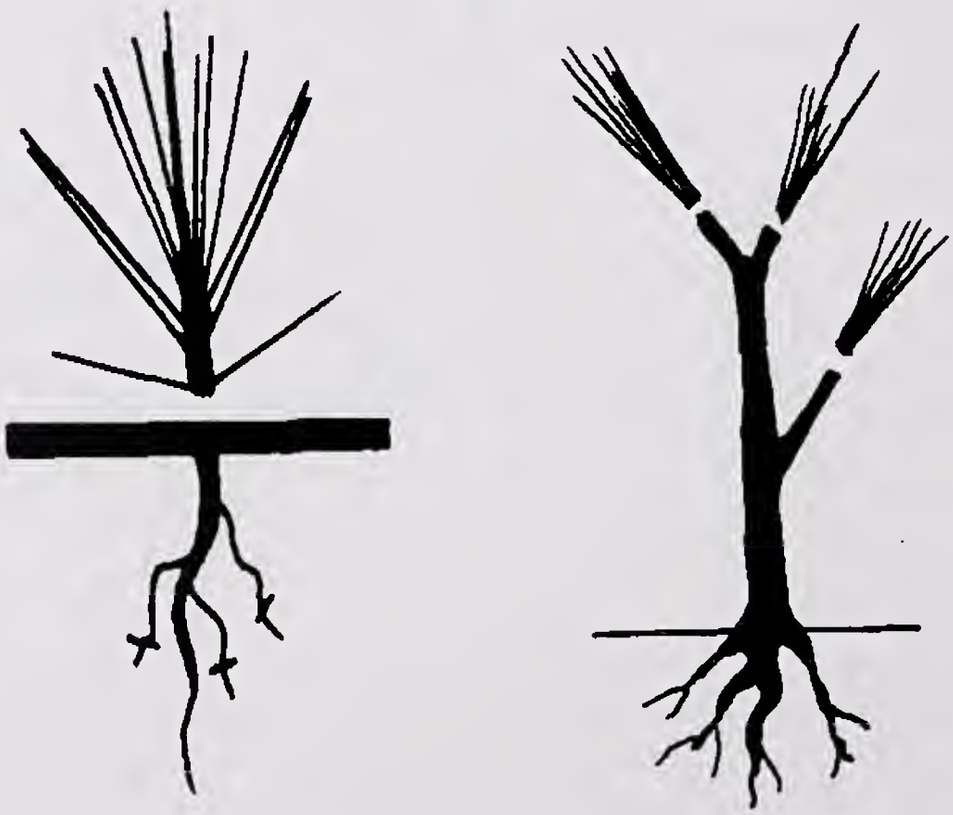


Fig. 4 *In the pine seedling let the shoot grow upto the point where you may desire to see the next forking point. The length of each line depends on your choice; here three different stages are shown.*

The artist's eye-balance, line & form

All parts of a bonsai planting-roots, trunk, branches and foliage must work together to achieve a unified effect. The concept of balance, proportion, form, line and appearance of maturity are essential in getting this aspect.

Balance and proportion depend on the location of branches and foliage, the placement of the plant in the pot and variation in the sizes of branches. Balance doesn't mean symmetry. It is very difficult to find a symmetrical bonsai. It also means even distribution - a heavy branch on one side is balanced by a curve on the other. The line of a planting indicates how the top relates to the trunk; the form or outline should be an asymmetrical triangle. All the above elements must blend harmoniously. (Fig. 5)

The most important part of a bonsai is the trunk. The structure of the trunk is central to the style. A thick trunk

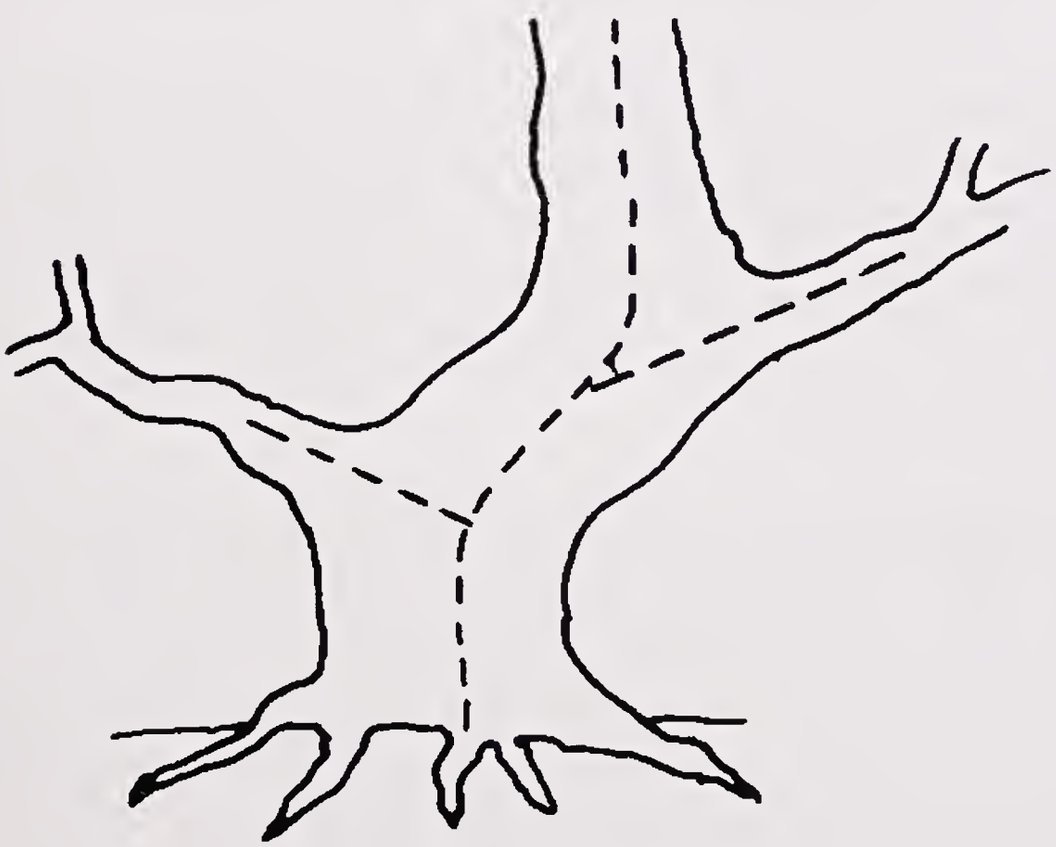


Fig. 5 *Lowest branch grows in opposite direction of curve on a curved trunk. This rule is used to create balance.*

Fig. 6 *Height of bonsai must equal about six times the width of the trunk at base*

shows a mature tree. It may not be actually as old as it looks. A too-thick trunk may make the tree look out of balance. The height of the tree may be about six times the width of the base of the trunk. It is a jungle rule. The real height depends upon the style of the planting, the thickness of the tree, and the spread of the lowest branches.(Fig.6)

Bonsai lovers avoid trees which are having perfect cylindrical trunks. It means the trunks whose thickness at the top is as much as the bottom. The trees with many curves in the trunk aren't very attractive. Trees with just one or two curves are more graceful. In most cases gentle bends or curves are better looking than abrupt ones. A trunk should never bend toward the front.

The trunk must taper with grace towards its terminal point. The top of the tree should never be just cut off to

Morus alba

create an apex. But if a tree is too tall, remove the top portion with a taper cut. The cut surface should face the back of the tree. You can also create jin by peeling of the bark at the apex.

Suppose, the apex is too low or is otherwise out of balance to the rest of the tree, you can remove the trunk just above a strong branch on the front side. Now a new apex can be produced with the help of wire. The strong branch going upward continues the trunk. Many times the scars from incorrect wiring and pruning techniques produce an ugly sight on the trunk. As a matter of fact highly desirable trunks should indicate aged, weather beaten characteristics. With experience you may create the illusion of age.

Branches

A bonsai is not simply a miniature duplication of a tree in the forest. In nature trees often branch profusely and randomly. Most bonsai, in contrast, have relatively few branches and those they have are selectively balanced.

The pattern of the branches makes the basic outline of the tree. Now it allows the trunk to be seen to its best advantage (Fig. 7).

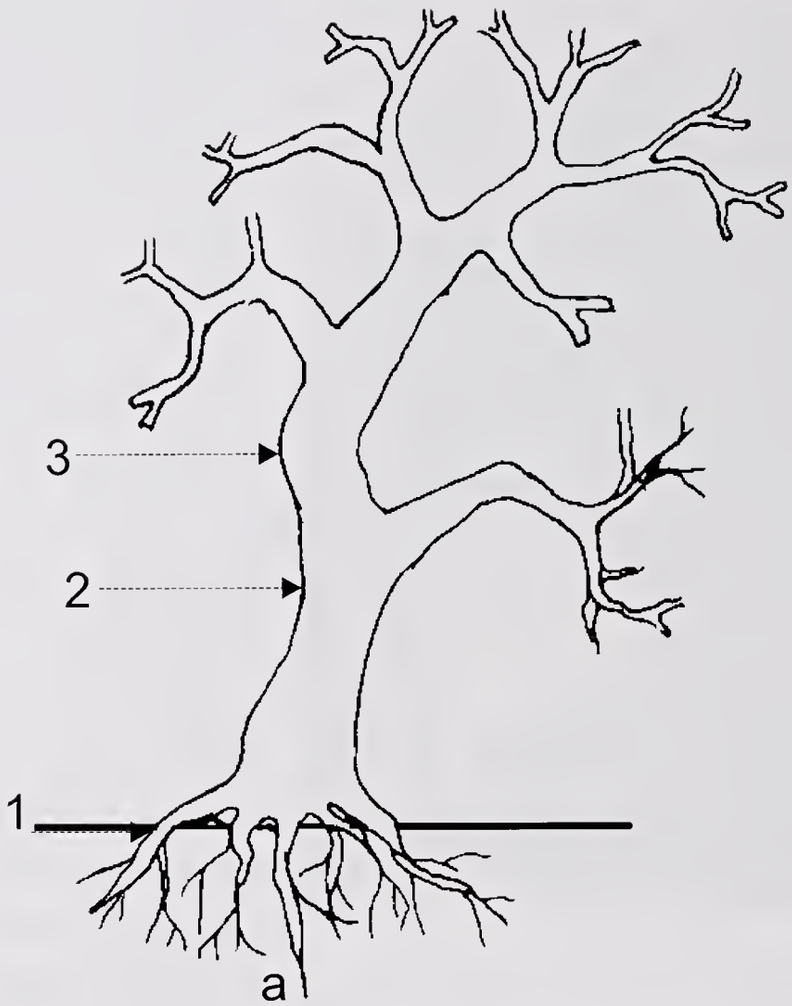


Fig. 7 *When producing a bonsai, all we are required to do is to reduce the dimensions of the single elements. If a tree is to be only 1/10 of the size of a normal one, the lines between one and two, and two and three should be 1/10 of the normal length.*

In the upright and slanting styles, the lowest branch must start about a third of the way up the trunk. This is the largest branch. This branch may extend out either to the left or to the right side. It is desirable if it moves slightly towards the front. With a slanting style or a curved trunk, this branch should move in the opposite direction of the slant or curve. Now a somewhat smaller branch may move in the opposite direction of the lowest branch and a little higher. Both of these two branches must angle slightly towards the front of the tree. At a level between these two is a branch extending out towards the back. (Fig. 8)

It is a general pattern and may be repeated to the top of the tree, the branches reducing in size as they grow

Fig. 8 *Branch 1 is largest branch; 2 extends out towards back of tree; 3 grows on opposite side of 1. This general model continues on up the tree. All branches slant down to provide a feeling of age.*

towards the top. Branches that extend directly out of the front of the tree should be eliminated. In no case the lower ones should be retained. Small, front-pointing branches in the upper third of the bonsai are known as ornaments. These can be retained if they contribute to the elegance of the design. Branches on opposite sides of the trunk must not be at the same level. A branch on the same side of the trunk should not be retained if it is directly above a lower branch. (Fig. 9)

In the semi-cascade and cascade styles, the branches closest to the roots are the biggest, with subsequent branches reducing in size as they move towards the top. At the apex a large branch growing upward out of the back of the trunk is normally retained. It is just before the cascade turns downward. In a bonsai the branches are supposed to vary in size and length. The space

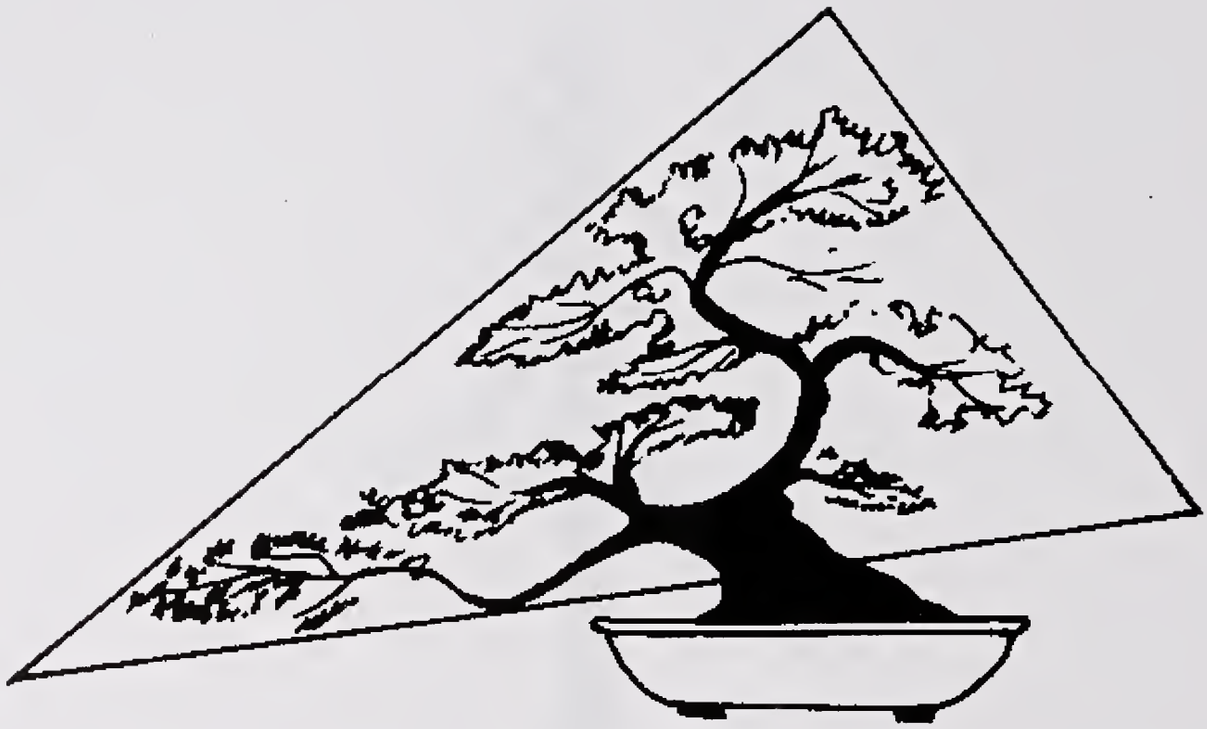


Fig. 9 *In the traditional bonsai design a rule of three is followed : Lowest point symbolizes earth; midpoint, man; highest point, heaven. These three points make outline of asymmetrical triangle.*

Juniperus sergentii

between branches also varies, slowly diminishing towards the top. In the formal upright style, the bottom branch is long and the next one is shorter. The other branches are still shorter. This may create an effect that is much too stylized and stiff.

A common rule is that the combined length of the two longest branches, usually the bottom two equals about half the height of the tree. But there are exceptions where the length of the two longest branches may be more than the height of the tree. In this case the trunk is unusually thick. The angle of slope is roughly the same for all branches.

The shape of the individual branch should appear narrow from the front and should taper towards the tip. Observed from the top, they appear to be wider near the trunk and taper to a point at the tip in a diamond, triangular or arrowhead shape. The diameter of the branches should be smaller than the trunk. If the diameter is too large it gives a sense of disproportion. It should be removed.

While shaping the branches the following general guidelines are recommended. The branches outlined below can be removed.

1. The branches that cross over in front of the trunk, parallel branches, branches with excessive bends in them.

2. Most front-growing branches (except the ornaments stated earlier) and any branches thicker in the middle or end portions than they are near the trunk. (Fig. 10, 11 and Fig. 12)

Foliage

The basic function of foliage is to reveal and complement the trunk and the branch structures. If the

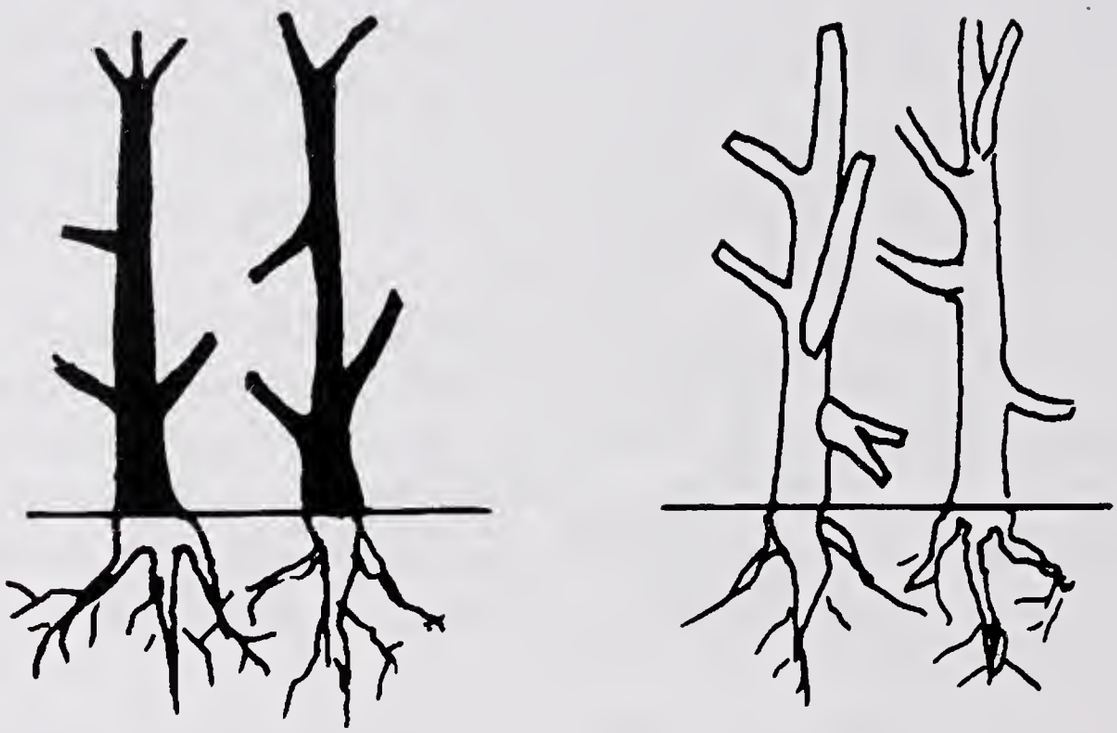


Fig. 10 *(Left) Avoid: three lines orginating from one point; laterals at a right angle; two laterals coming from the same level, (right) This design is better. (Left) Two laterals at the same angle; main branches on lower front of trunk; two laterals coming from one point (right) It looks better.*

Fig. 11 *The Diagram indicates how you should cut back branches to get a rounded or broom shape to your tree. Careful pruning will give a good shape.*

Fig. 12 *It is front view. The branch configuration as seen from front shows that no branches extend towards front.*

foliage is thick, it may obscure the structure of the tree. If the foliage is too sparse it indicates bad health of plant. Ideal foliage is small and compact. It grows in dense style. The leaf should exhibit life and power. It is possible to control the growth of the leaves. You can also control the location from where a leaf should grow. You can also control the size of the leaves.

You may be able to reduce the size of some leaves by leaf cutting particularly in old trees but you can not reduce the size of flowers and fruits. Therefore, in case of flowering the fruiting trees, the dwarf species are generally selected for bonsai.

Roots

The appearance of the roots that are exposed is quite important. In a typical bonsai you should be able to see the crown of the tree, where the roots meet the trunk, as well as the tops of the large roots, as they grow out from the base and down into the compost.

The surface roots should have a good root structure. The roots should spread out in all directions providing a picture of varying sizes and spacing. An exceptionally big protruding root should be at the back of the tree. It should never be in the front.

Front and back of the bonsai

It is meaningless to think about the front and back of a tree when it is growing in a forest. But the bonsai is a

Ficus religiosa

work of human art. For a bonsai, front and back are very important.

When you are training a plant the first consideration is its front. The front shows the structure of the tree to the viewers. For finding out the front look down on the bonsai from above to see in which direction the apex leans. It should lean towards the front. The front should be relatively open and airy. No large branches should protrude directly towards the viewer. The front should not have a large protruding part of a root. When you are training your bonsai in deciding the front, the first consideration is the beauty of the plant. It is a subjective judgement and can be made only after careful study of the tree, other bonsai and trees growing in the forest. (Fig. 13)

The back of the tree is very important because the rear-growing branches create a feeling of substance and the depth. Bonsai should not be only two-dimensional - they require a powerful three-dimensional look. Back branches help establish this look and provide an elegant backdrop of foliage. In this context front-growing

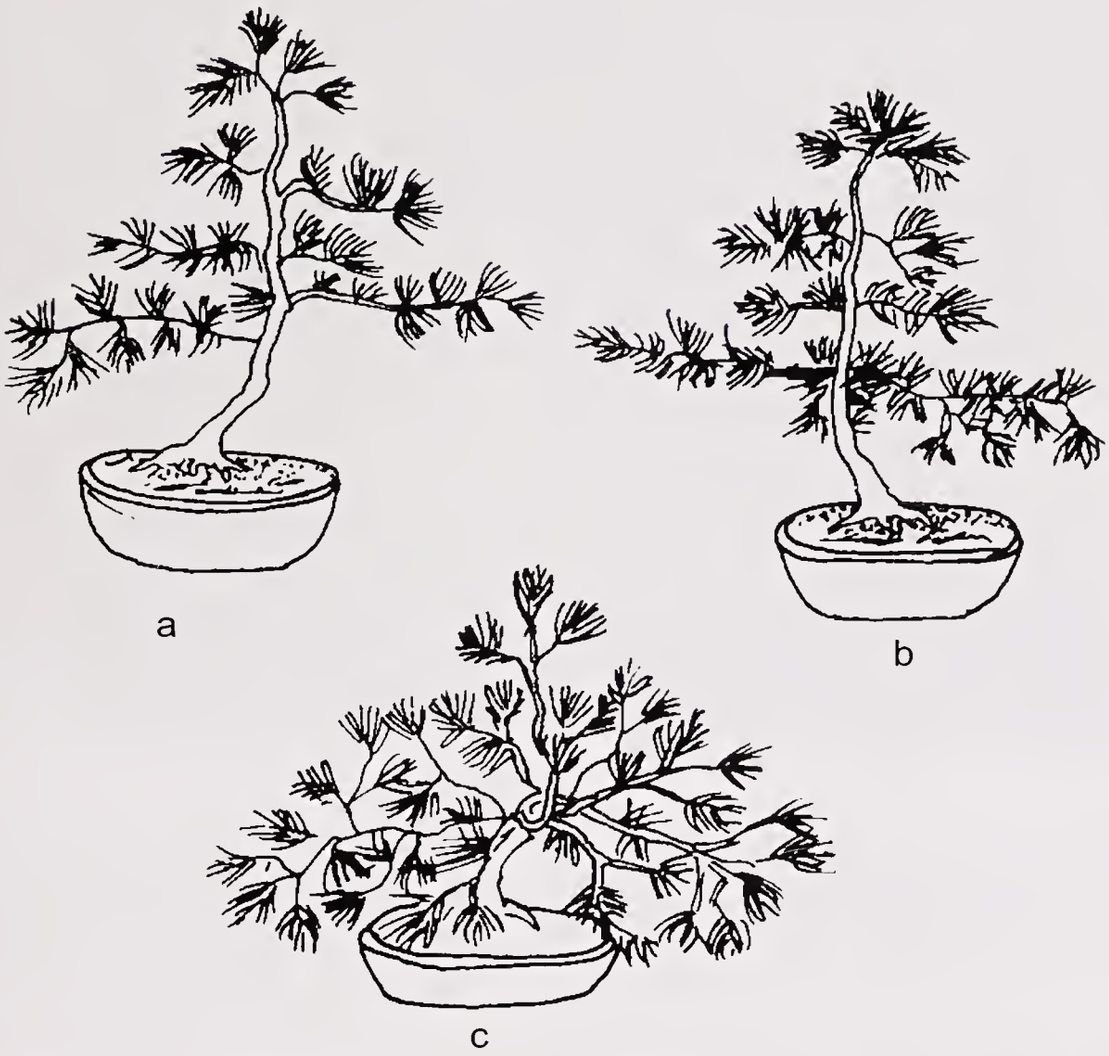


Fig. 13 *(a) The front of the tree shows open feelings. No branches extend towards the viewer, (b) The back of tree shows more branches to create a feeling of depth, (c) The top view indicates nice placement of branches. The apex leans towards the front.*

branches are often undesirable. Though the back is not viewed directly, it should be nicely tended. The branches should not be awkwardly shaped or overpowering. (Fig. 14)

Principles of design and some variations

Here are some basic rules valid for all shapes :

1. Reduce the distances between forking points gradually, the farther you move away from the trunk.

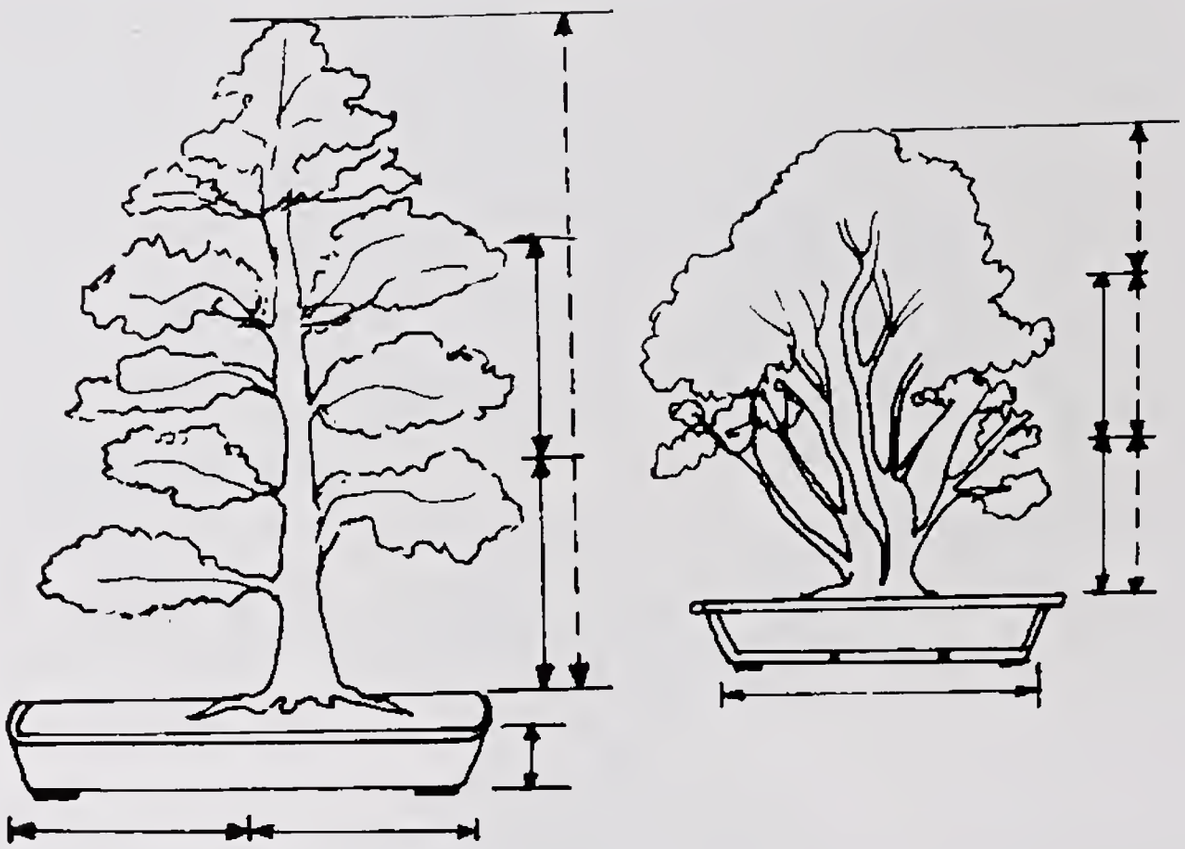


Fig. 14 *The depth of the pot should equal width of the trunk at its base*

The length should approximate two-thirds a height of the plant or in a multiple-trunk style, height of tallest trunk

2. Ignore long straight line. But change the direction quite frequently.
3. The lower part of the tree should not have any crossing lines. It is only in the upper part of the top where a crossed-line, some times can be tolerated.
4. Develop foliage judiciously. The framework is the most dominant feature.
5. Do not cover the trunk and main branches with other branches which grow too low at the front. A lower branch at the back can be complimentary to the framework.
6. Avoid any symmetry of lines because these are artificial and unnatural.

Malpighia

7. The overall lines should indicate drooping. This can be done with the help of weights for bringing branches to downward position.

Living plant

The vital needs of a plant are like our own-light, water, air, food and warmth. The relative importance of each of these needs varies widely between different plants, but within a particular species the requirements are the same whether the plant is developing in its natural forest or in your compound.

In a bonsai, the plant's requirements are the same but its environment is completely changed. A plant in a pot in the house is in an entirely artificial situation. The plants may adapt, but there are limits. Beyond these limits you should take over from nature the complete responsibility for meeting the needs of the plant. If you understand basic facts about the way in which plants exist and develop you shall be able to grow them successfully.

Adenium obesum

To manufacture carbohydrates and proteins which a plant require to grow needs raw materials, mineral salts such as nitrogen, phosphorus, magnesium, potassium, sulphur and calcium absorbed from the soil of the pot through the fine root hairs. The water taken up provides hydrogen while carbon dioxide and oxygen are absorbed from the atmosphere through the very small pores, of the leaves. The very small pores are known as stomata. Light is essential to change these raw materials into food. In daylight, light energy from the sun is absorbed by chlorophyll, the green pigment in the plant cells. Light energy is utilised to split the water into hydrogen and oxygen molecules. Hydrogen combines with carbon dioxide, absorbed from the atmosphere, to form a sugar compound. This process is known as photosynthesis. The

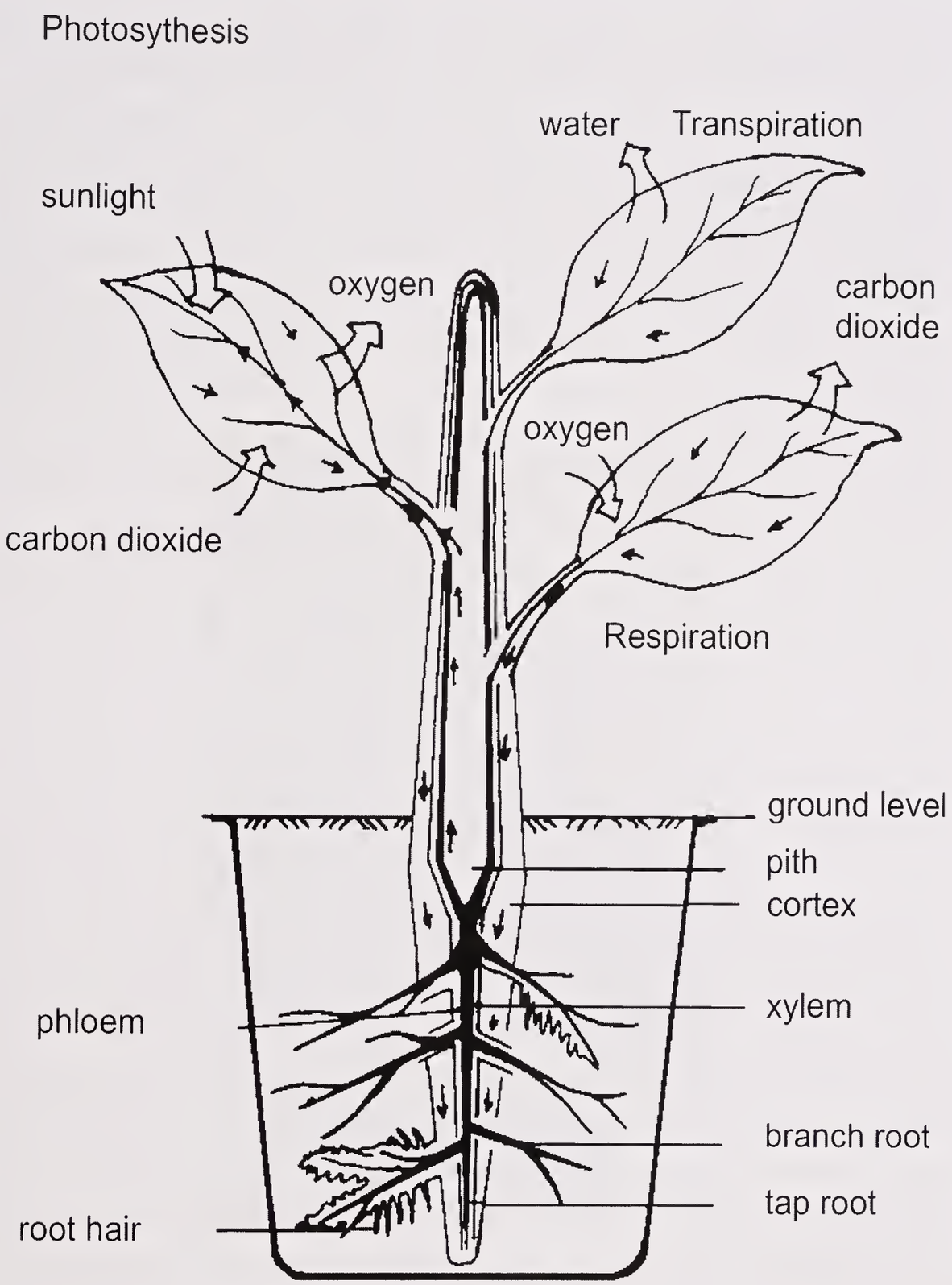


Fig. 15

plant uses the sugar as food. It is changed into energy to drive all the plant's vital activities and to allow it to grow. The conversion into energy takes place by breaking down of the sugar with the oxygen absorbed by the leaves in a

process called respiration. This process, unlike photosynthesis takes place day and night. (Fig. 15)

The different elements absorbed through the roots have differing roles. They assist in the process of photosynthesis, the production of carbohydrates and protein, in the development of flowers, leaves, roots and seeds and in the maintenance of the general good health of the bonsai. The most obvious responsibility is in giving sufficient light for photosynthesis to take place. This may not necessarily mean direct sunlight. It is the energy that light produces that is important and even artificial light may be sufficient. "Sufficient" light means roughly the level of light natural to that particular plant in its natural surroundings. It may be forest shade or desert sun. A plant may tolerate lower level of light, but this should not go too far. While a plant deprived of its normal requirement of light may not die, it definitely will not flourish. Plants are more sensitive to the level of light than humans are. You can use a light meter to understand the need of light for your bonsai. In case the light is less, the signs on your plants are dramatic-such as death or more subtle; sometimes the plant grows leggy and the leaves stay small, the young leaves grow pale and old leaves turn yellow, variegated leaves turn totally green or flowering plants fail to bloom. If you find any of these signs early, put the plant in better light. You should be very careful in keeping plants in better light because too drastic a change can be harmful. There is a process known as phototropism. Light from only one direction will cause a plant to bend towards the light source. If the bonsai is not tuned until the plant has bent over it will become distorted. It is best to mark the pot with a cross so that you know its position and then turn the pot a little each day. The plant will then grow upright.

Apart from a certain level of light, the bonsai plant must also be given the appropriate level of temperature.

The grower's responsibility for providing water is total. It is the main function you should take on when deciding to grow bonsai. Plants are dependent on the water you provide them for the supply of hydrogen for photosynthesis and for dissolving the minerals in the soil to be taken up by the roots. The plant also depends upon you not to give it too much water, for waterlogged soil does not hold the air without which the root hairs cannot function and will die.

Ficus nuda

Various functions associated with living plant

Photosynthesis is the chemical process by which plants produce their own food. Light is absorbed by the green pigment chlorophyll in the leaves and used to convert carbon dioxide (which has been taken from the atmosphere) and water into sugar and oxygen. The

oxygen is then released into the air, respiration is in some ways the reverse of photosynthesis and provides energy needed by the plant. Oxygen is combined with sugar to release energy, Carbon dioxide and water are by-products of this reaction. Transpiration is the process by which water is drawn up to the stem of the plant. The continual evaporation of water from the stomata, or pores, in the leaves causes a "stream" of water to move from the roots to the leaves.

The roots, stems and leaves are three major functional organs of all plants. The roots anchor the plant in the soil and absorb both water and mineral salts. They also store a certain amount of food. The stem conducts water and mineral salts from the roots. The stem also distributes sugar, which has been manufactured in the leaves, to other plant tissues that require it for growth, or it stores it for future use. The stem also holds the foliage up towards the light, which is necessary for the process of photosynthesis, the primary function of the leaves. A secondary function is that of transpiration, during which excess water is returned to the atmosphere.

The stem is surrounded by a protective epidermis. The underlying cortex is made up of a variety of cell types, which store food and water and also give strength to the stem. The conducting tissues, known as the vascular bundles, consist of elongated tubular cells - phloem and xylem. Phloem carries sugar from the leaves and xylem carries water and nutrients from the roots.

The leaf has a one-cell-thick layer of enveloping epidermal cells which is pierced by many stomata, or pores. These govern the rate at which water, oxygen and carbon dioxide are taken in or given up. Between the epidermis is the mesophyll, which contains the chloroplasts that are necessary for photosynthesis. A waxy cuticle prevents water loss.

The root hairs absorb water and mineral salts. The

water passes from the root hairs into the cortex. An inner layer of cells, the endodermis, controls the amount of water that enters the xylem. The phloem brings food from the leaves.

The quantity as well as quality of light needed by a bonsai plant has to be taken into consideration. Some plants, known as long-day plants, need long periods of light to produce flowers; others, called short-day plants, will grow flower buds only when light is restricted to less than twelve hours. Most chrysanthemums are short day plants.

The bonsai can also be kept indoors. But it can not be kept indefinitely. In case you want to break the law of nature then there are special horticultural tubes, that give a purplish light which many bonsai lovers may not like. An ordinary incandescent light hanging from the ceiling is not very effective as far as bonsai plants are concerned. Spotlights are more decorative but less useful, and if they are too close to a plant they can be harmful. Fluorescent

Hibiscus rosa-sinensis

tubes provide adequate light fairly cheap, without heating the plants. The colour of the light emitted by the tubes is important. While a "warm white" tube can be used for bonsai plants, an effective light for growing bonsai plants is given by one 40-watt "cool" tube and one 40-watt "daylight" tube. These may be fixed 45 to 75 cm above the tops of the bonsai plants. The plants will soon indicate whether you have the distance right. If the leaves curl they are too near the light. If the stems become elongated the plants are too far away from it.

Lighting units are quite popular among keen bonsai growers, especially in the advanced countries. A lighting unit consists of a tray to hold the plants, supports for the lights, which can be adjusted to different heights, and a hood over the fluorescent tubes to reflect the light on to the plants. You may remember that under these fluorescent lights plants transpire more water than usual. Due to this reason more water is provided under artificial light conditions. You should also remember that in a fluorescent tube the brightest light is at the centre. The intensity of the light diminishes with time and the plants are very quick to feel it. The tubes should be replaced as soon as you find them giving reduced light.

The plant is almost as dependent on you for nutrients as it is for water. For them this dependence is more acute, because the container is very small. Although the plant may have some reserve in the soil or compost in which it is planted that will cushion your neglect provided the container is big enough. In a bonsai the plant can not send out more roots in search of nutrients. Feeding has to be carried out during the growing season. It is very important to remove the roots as the plant grows. The plant requires vital oxygen and carbon dioxide. For this you should keep both sides of the leaves clean. The leaves should be free of dust particularly from the undersides because it has stomata.

Suitable Plants

These plants can make good bonsai:

Plants grown for flowers

Acacia arabica (Babul); *Adansonia digitata* (Baobab); *Adenium obesum* (Desert rose); *Bauhinia galpinii* (Pride of the cape); *Bauhinia tomentosa* (Bell - bauhinia or St. Thomas tree); *Berberis aristata* (Barberry); *Brunfelsia Pauciflora* (Kiss me quick); *Brya ebenus; Bombax malabaricum* (Silk cotton tree); *Bougainvillea; Butea monosperma* (Flame of the forest); *Caesalpinia pulcherrima* (Krishnachura); *Calliandra haematocephala* (Powder puff); *Calliandra inaequilatera* (Red powder puff); *Callistemon citrinus* (Bottle brush); *Cassia artemisiodes* (Wormwood); *Cassia fistula* (Golden shower); *Chorisia speciosa* (Floss - silk-tree); *Cupheajorullensis;* Cydonia japonica (Japanese quince); *Duranta repens* (Golden dew drop); *Delonix regia; Galphimia gracilis; Gardenia radicans Syn. Gardenia jasminoides* (Cape jasmine); *Hamelia patens Syn. Hamelia*

Portulacaria afra

Manikara haxandra

erecta (Scarlet bush or Firebush); *Hibiscus rosa-sinensis* (China rose); *Ixora species; Jacquinia aurantiaca; Jacquinia ruscifolia Syn. Jacquinia aculeata; Jatropha podagrica (Gautemala rhubarb); Lantana depressa; Michelia champaca* (Fragrant chapaca); *Malpighia coccigera* (Japanese holly); *Millingtonia hortensis* (Cork tree); *Miniature roses; Murraya exotica* (Kamini); *Mussaenda luteola; Myrtus communis* (Greek myrtle); *Nerium Oleander* (Oleander); *Peltophorum inerme* (Rusty shieldbearer); Parkinsonia aculeata (Jerusalem thorn); *Plumbago capensis* (Cape leadwort); *Prunus sieboldii* (Japanese flowering cherry)

Adenium arabica

Plants grown for fruits

Anacardium occidentale (Cashew-nut); *Anona squamosa* (Custard apple); *Ardisia crispa; Carissa carandus; Citrus aurantifolia* (Lime); Feronia *limonia* (Wood apple); *Fortunella japonica* (Kumquat); *Inga dulcis; Mangifera indica* (Mango); *Manilkara zapota Syn.Achras zapota* (Sapodilla); *Moringa oleifera* (Drum stick); *Phyllanthus emblica* (Indian star gooseberry or Emblie); *Psidium guajava* (Guava); *Psidium cattleianum* (Strawberry guava); *Punica granatum 'nana'* (Dwarf pomegranate); *Punica granatum* (Pomegranate); *Syzygium cumini* (Jamun); *Tamarindus indica* (Tamarind); *Termmalia catappa* (Indian almond)

Morus alba (Mulberry)

Ficus vrens

Some other very promising plants

Abies species (Fir); *Combretum species; Cotoneaster horizontalis* (Rock cotoneaster); *Derris scandens* (Flame tree); *Ficus carica* (Fig); *Lemonia spectabilis; Morus alba* (Mulberry); *Phoenix roebelenii* (Pygmy date -palm); *Pinus parviflora* (Japanese white pine); *Plumeria rubra* (Frangipani tree); *Prunus avium* (Flowering cherry); *Prunus persica* (Peach tree); *Rhododendron kurme hybrids; Samanea saman* (Rain tree); *Saraca indica* (Sita ashok); *Serissa foetida variegata* (Serissa japonica); *Tabebuia rosea* (Rosy trumpet tree); *Tecomaria capensis* (Cape honeysuckle); *Thespesia populnea* (Portia tree); *Thevetia nerifolia* (Yellow oleander); *Tibouchina semidecandra* (Glory bush)

Plants grown for Foliage

Araucaria bidwillii (Monkey puzzle); *Araucaria excelsa* (Norfolk island pine); *Azadirachta indica* (Margosa or

Ficus retusa

neem); *Bambusa nigra; Bambusa multiplex* (Fern leaf bamboo); *Breynia nivosa* (Snow bush); *Cupressus arizonica* (Arizona cypress); *Cedrus deodara* (Deodar cedar); *Crassula 'Jade necklace'; Crypytoemeria japonica; Cycas revoluta* (Sago palm); *Casuarina equisetifolia* (Horse tail tree); *Ficus benghalensis* (Banyan tree); *Ficus benjamina* (Weeping fig); *Ficus diversifolia Syn.ficus deltoidea* (Mistletoe fig); Ficus glomerata (Cluster fig); *Ficus infectoria* (Pakur); *Ficus krishna Syn. Ficus benghalensis* krishna-Sacred fig tree; *Ficus parcellii Syn. Ficus aspera* (Clown fig); *Ficus religiosa* (Pepal or Bo tree); *Ficus retusa* (Chinese banyan); *Ficus roxburghii Syn. Ficus auriculata* (Ornamental fig); *Furcraea foetida; Grevillea robusta* (Silver oak); *Juniperus chinensis sargentii; Juniperus communis 'Prostrata'; Lawsonia alba* (Henna); *Mimusops elengi* (Medler); *Murrraya koenigi* (Curry-leaf tree); *Pinus densiflora 'Pendula'* (Weeping Japanese red pine); *Pinus khasiana; Phyllanthus nivosa Syn. Breynia nivosa; Pinus roxburghii* (Indian long leaf pine); *Podocarpus macrophyllus* (Buddhist pine); *Portulacaria afra* (Elephant bush); *Putranjiva roxburghii; Thuja orientalis compacta* (Oriental arborvitae)

●

BONSAI STYLES

Generally, bonsai are grouped according to size, attitude and number of trunks coming out from a single root, number of trees in a group planting, and the kind of base the plant shows.

Classification based on size

A bonsai may grow anywhere from just a few centimetres high to 90 to 120 centimetres or rarely more. The size classification may be as under :-

Miniature bonsai	-	under 15 cm.
Small bonsai	-	from 15-30 cm.
Medium bonsai	-	from 31 to 60 cm.
Large bonsai	-	over 60cm.

Mame Bonsai

Mame bonsai can be held comfortably in the palm of the hand. The size should not exceed 8-15 cm in height and, with few exceptions, their care and shaping is the same as for their larger counterparts. The mame bonsai plants can be collected from the forest or you can make them from cuttings and seeds, by growing them from offshoots or by buying them from nurseries. Mame requires to be grown for between three and five years to shape the tree conveniently so that they are true to the name. It is possible to start with seedlings 3-5 cm tall, easily obtained from a forest or near the foot of large trees. Many of these small seedlings are in an interesting shape even at this stage. It is true that mame should be

Ficus nuda

miniature copy of the original tree, not some awkward deformed plant.

Spring for the deciduous plants or the rainy season for the evergreen plants, is the best time of the year to go searching for suitable plant materials. Dig the plant out carefully without damaging the root fibres, but remove the tap-root. Some earth should be left on the roots. Now this plant should be wrapped in damp moss or moistened newspaper to avoid drying out. The choice of container is a matter of individual taste. The container should have a sufficiently large drainage hole in the bottom. The correct soil mixture is important for the survival of the plant. You can use bonsai soil mixtures. The mix has to be very fine. Mame bonsai, may need water at least two times daily, more frequently in summer, depending on temperature and wind. One way is to dip the tree in water until no more air bubbles come to the top.

Pruning is very important operation to obtain correct shaping of a mame bonsai, since the plants are too small to permit much wiring. The young trees can be pruned

back to one or two buds. Repeat until the plants begin to look more graceful. Then stimulate some of the tiny shoots to grow and remove the more dominant ones with your hand.

If you want to achieve a mame with descending shoots, you may either bind branches with copper wire or tie a string round the container. Now the branches can be pulled down as much as possible with some thread and it should be tied to the string.

The fertiliser is applied sparingly. Diluted liquid fertiliser is ideal for mame. Along with it a liquid manure can also be applied once a week. Many growers inject fertiliser through the drainage hole at the bottom of the container. After some time the mame exhaust their soil because they are more prone to this since they grow only in a few tablespoonfuls of it. Therefore, the mame is to be repotted more frequently than larger bonsai. At the time of repotting, the roots should be removed by a third.

The foliage of the mame should be sprayed daily. In the beginning the small plants should be protected from sun and wind for about a week. Then it can be introduced to the sun.

The mame generally may survive for hundred of years but they can remain for two to three generations if looked after properly.

Classification according to shape and trunk

Most bonsai fall into the following classifications :

Single trees

The following are single trees with one trunk development in pots. (Fig. 16)

Chokkan : It is an upright tree having a vertical trunk and progressively smaller branches. The branches are

developed symmetrically, giving a pyramidal shape. It is commonly seen in big conifers.

Moyogi : It is almost an upright tree. The development of the trunk is spiral, but it decreases towards the crown.

Shakan : It is a tree whose single trunk leans sharply either to the right or left. The branches are fairly uniformly developed and are positioned on opposite sides of the trunk.

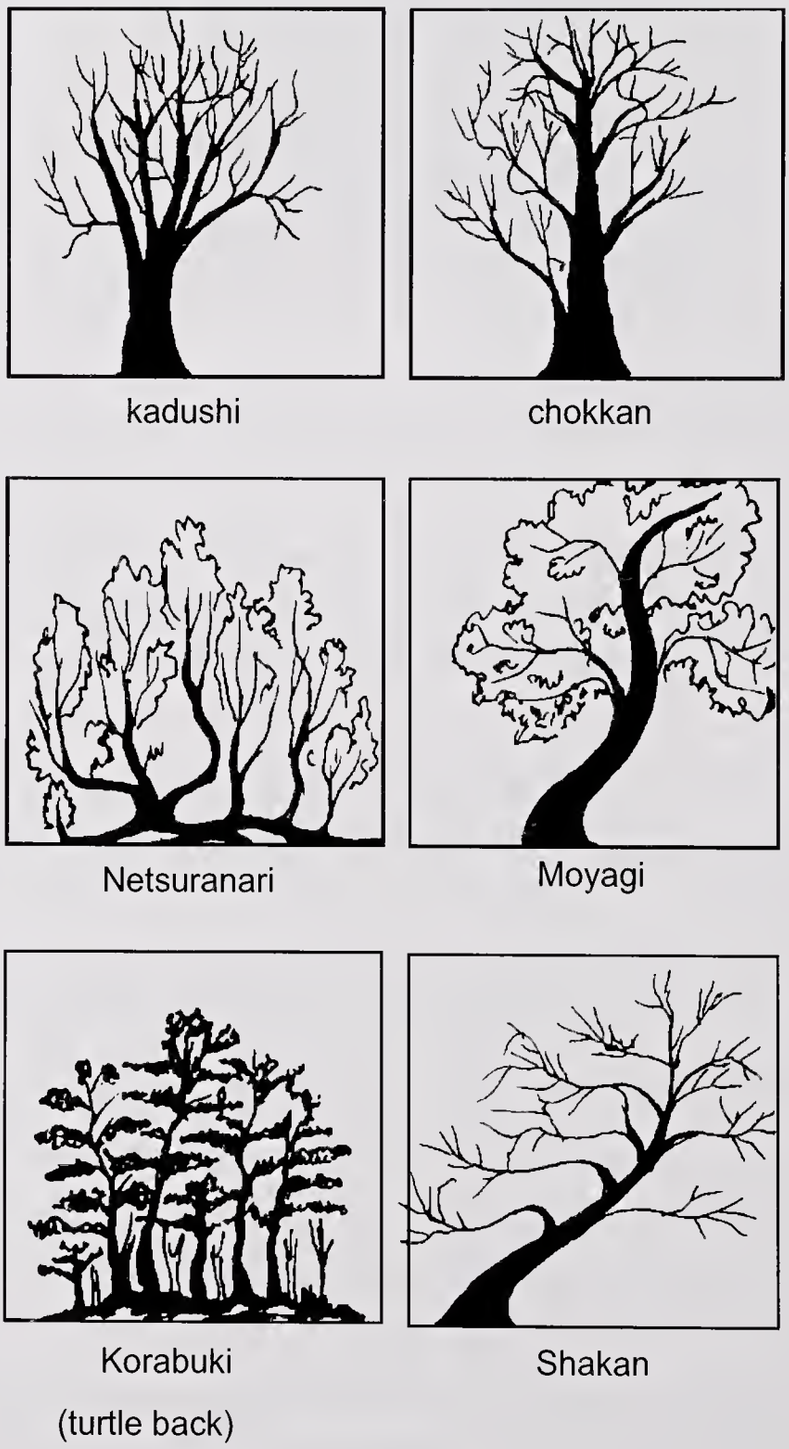


Fig. 16

Bankan : It is a tree in which the trunk is curved and twisted. In many cases the trunk may look knotted.

Hen-Kengai : It is a semi-cascading style. This style is seen in plants whose branches develop out of one side of the trunk. The semi-cascading form is not really weeping.

Kengai : It is a cascading tree with a clear bent trunk. The branches hang over the container.

Fukinagashi : It is also called 'windblown'. The trunk leans to some extent and the branches grow in the same direction. It appears that plant is battered by the wind.

Shitzuki : It is a style for plants grown on or in the crevices of big stones or boulders. Some plants develop a graceful arrangement of knotty aerial roots.

Bunjingi : It is a 'Literati' style of tree, copying calligraphy. It is an elegant form which indicates a slightly slanting trunk, whose branches and leaves develop only at the crown.

Hokidachi : It is an upright tree. The branches start to sprout out at a particular height, providing it a typical broom-like appearance.

Tree with multiple trunks

One strong, main trunk usually dominates one or more secondary trunks. Traditionally, except in the double-trunk style, you may avoid even numbers. The following are examples in this classification.

Sokan : It is the simplest form where a double-trunk grows from a forked base.

Sankan : In this case there are three trunks growing out of one stock.

In the above two examples the size of the trunks coming out of the base must not be identical. In the sokan, two trunks grow from a common root system. One trunk is bigger than the other. In this form, you should maintain

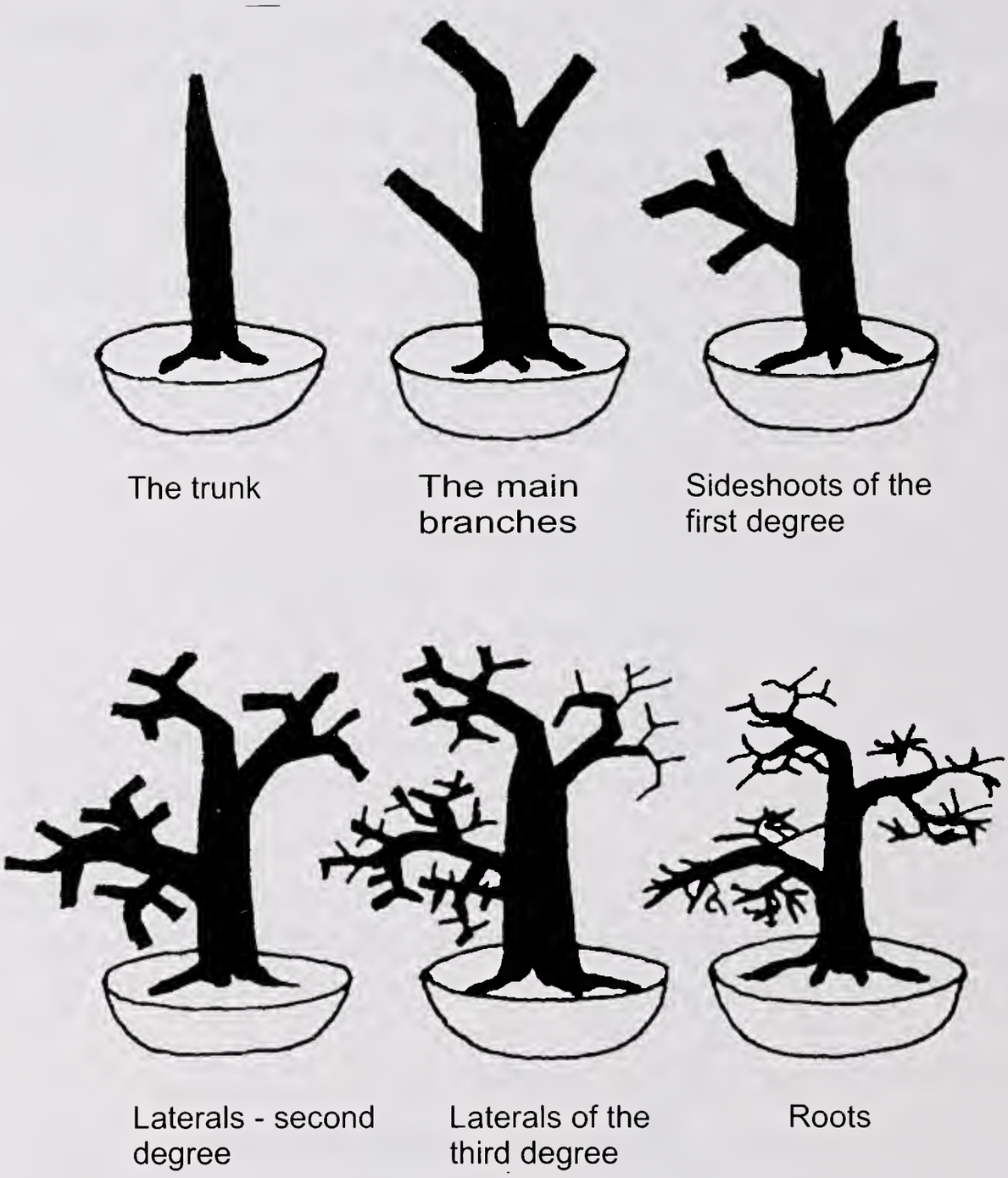
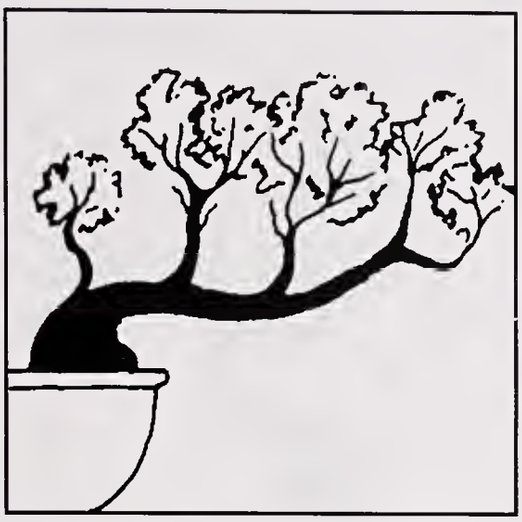


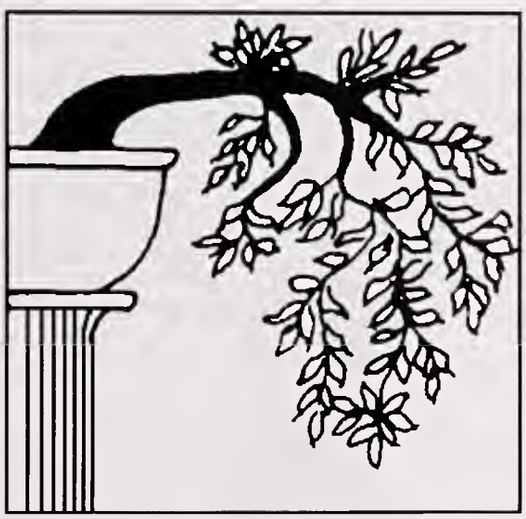
Fig. 16-1

constant proportions between the two trunks : if the bigger trunk is twice as thick, it should also be twice as tall. One trunk can be slightly in front of the other, producing a picture of depth ; one should never be directly in front of the other. If the trunk curve, they must curve in the same direction. You should not allow a branch of the larger trunk directly above the branch of a smaller trunk. The branches from one trunk should not



Han-Kengai

Bunjingi



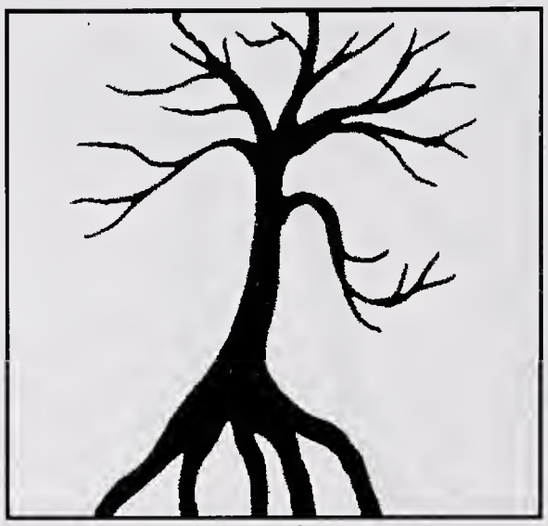
Kengai

Hokidachi

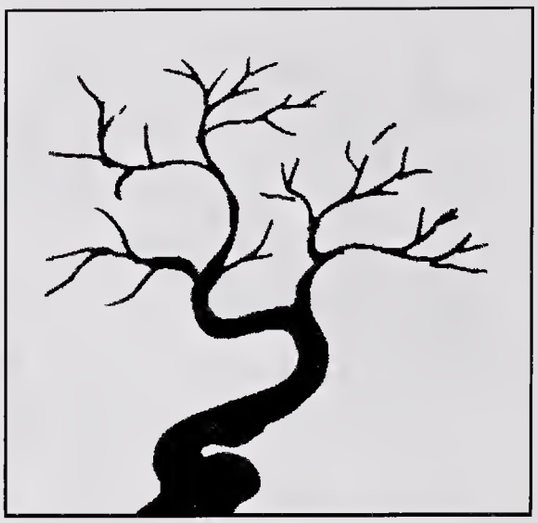
Fukinagashi

Ishitsuki

Fig. 16-2



Neagari
(roots are visible

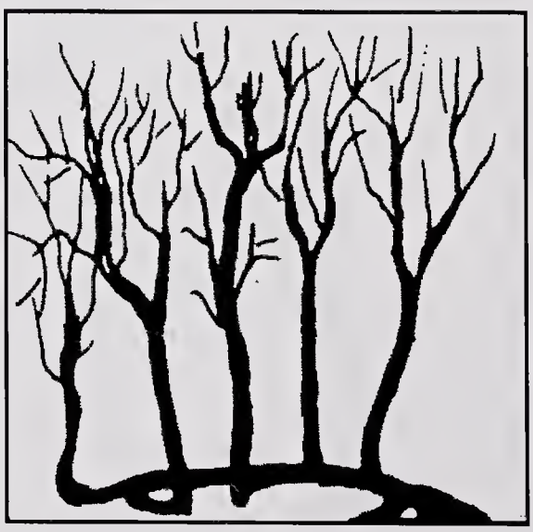


Nejikan
(trunk is twisted)

Sabamiki
(It is cleft trunk)

Sankan

Sokan



Ikadabuki

Fig. 16.3

cross those of another. If the space between trunks is close, you should train the branches as though the two trunks were one. In the sokan style one trunk is thicker than the other: this becomes the 'father', the other trunk can be considered the 'son'. In the sankan style two trunks are thicker than the other and these are the 'mother and father'. The smaller trunk is the 'son'.

Kadushi : This style indicates a series of trunks with multiple branches coming from a single root. An odd number to trunks is maintained.

Ikadabuki : It is known as raft or straight-line style. These multiple trunks grow in a straight line because they are really branches coming from a trunk that has been laid on its side under the soil and has become a root.

Netsuranari : It is also known as sinuous style. This tree is much like the raft style except that the single root weaves about under the soil, making the trunks to form a curved line.

Group planting

It is called yose-uye. The group plantings are composed of trees with separate root systems, For a two-tree planting, you should follow the guidelines stated for double-trunk plantings. You should always have odd numbers of trees. To produce a forest effect, you need at least five or seven trees. (Fig. 17)

In a group planting, the overall influence is more important than the beauty of the individual trees. One tree has to be larger than all others-not to invite attention to itself but to become a focal point to the viewer while smaller trees play nearer the edges of vision, giving the group planting effect. Because the individual trees merge with the group, forest plantings are ideal settings for trees with defects that are too visible to be displayed as individual plants. In group planting, the spacing between

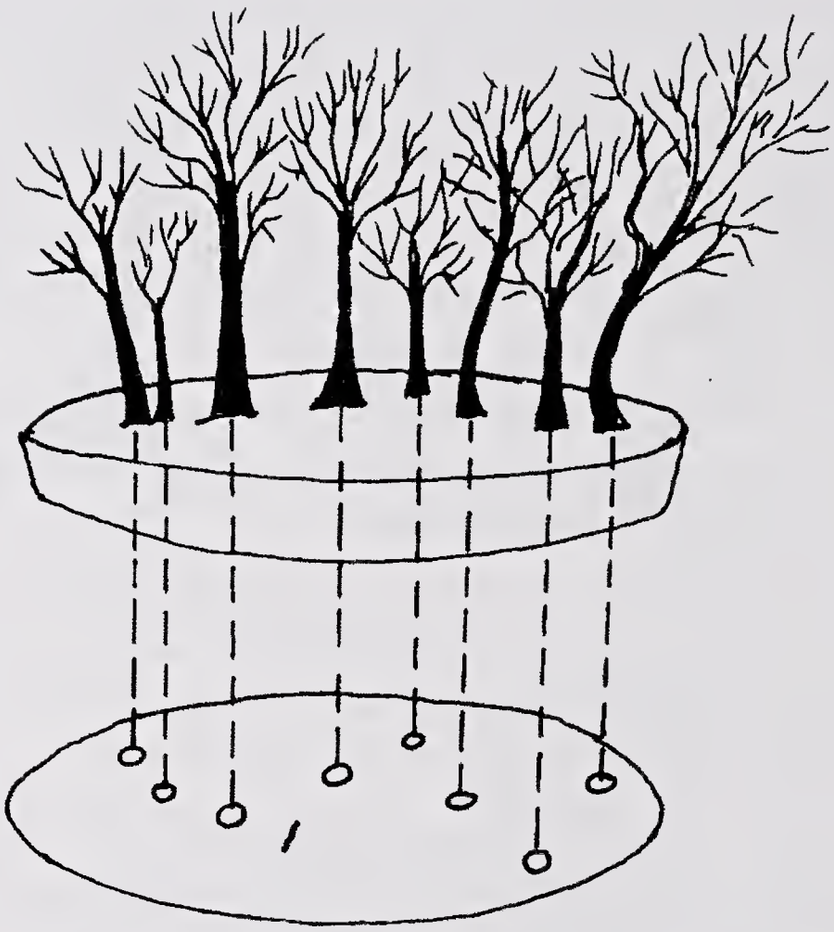


Fig. 17 *Planting designed to produce a miniature forest*

trees is not kept uniform, and two trees are not of the same size.

Group planting may include, if not identical plants, then similar trees with similar requirements. The outline of the whole system within the planting, may form roughly an asymmetrical triangle. The planting is not symmetrical, with the biggest tree directly in the centre of the container; rather, the plants are grouped near the edges, frequently with much open space left in the pot, allowing space to produce a picture of visual effect. Normally the largest tree is planted in the front and the smallest trees are placed in the back. You may prune most of the inside branches.

TECHNIQUES OF DEVELOPING BONSAI

In the conventional technique a strong link is seen with the early beginnings of bonsai where the plants stunted in growth, were taken out from forests or open grounds. In this system the disadvantage is that the roots have thickened in the same proportion as the trunk. Consequently a three year old plant is to be pruned back to a point where one is left with the thick parts of the roots close around the trunk. It is difficult to stimulate new growth on the old wood because the roots immediately surrounding the trunk have hardened to the same ratio as the trunk. Clearly, the results are not encouraging in this method. When the roots have thickened, the quantity of fine roots is reduced. The fine roots (less than 2 mm in diameter) have the better capacity of absorption of water and the nutrients. In fine roots, the apical meristem lies at the apex of the root representing their growing regions. Similarly the old wood has reduced ability of growth because apical meristem lies at the apex of growing point. The cells grow and assume distinct shapes to perform definite functions. The cells give rise to tissues. Tissues may primarily be classified into two groups : meristematic and permanent. Only the meristematic tissues are in a state of division or retain the power of diving, which the old wood and thick roots lack.

In the conventional system, the thickness is achieved first and the unwanted growth is eliminated later on. A shoot is allowed to grow freely until the end of the

Ficus religiosa

growing season and then cut back to the desired level. In the older, established trees, stopping during the latter part of the growing season or in the rainy season when the growth is active, encourages only smaller secondary growth. In winter, the growth may come to a seasonal stand still. Nothing substantial is gained.

The conventional system relies mainly on restriction of root formation as the dwarfing factor. Therefore, the plants are kept in small containers from the very beginning as it happens in nature where retarded growth is produced. The root growth is uneven and small in nature. The dwarfing effect achieved is negligible and applies to a small group of species.

The training starts in the second or third year after germination of seed in this method. The thickened stem is the primary objective as in the early days when only plants dug out of the ground were used. The thick roots are pruned round the stem to fit the bonsai container.

The thick roots are slow to produce new capillary roots as stated above. The soil used is also small in amount, resulting in limited nourishment due to limited root system which is also uneven and slow. The accent on shaping lies in wiring. Copper wire is used over a protective layer of raffia running in coils around the branch.

In this method, grafting and cuttings are also used. The cutting is used in pomegranate, cherry, peaches, plums and mulberry. The grafting is used in mango and guava.

A further disadvantage of the conventional system is the uneven growth of upper portion as stated above. The grower has to convert existing material into harmonious shape and the required appearance. The grower is left with little choice with respect to the selection and placing of all branches. The final structure is a compromise, a concession to the existing structure which was obtained in nature. The difference in thickness between the trunk and the branches can only be overcome in several days. It is difficult to place dwarfing effort on old wood and old roots. Therefore, this system forces dwafing through stunting and is effective only on small leaved species.

For making of instant bonsai, older plants are used, taken from forests or old nursery stocks. This means a procedure where an old fashioned dress is changed with a new design. The grower uses the existing material in making bonsai with the help of selective and severe pruning. If the material contains enough growth, the results are satisfactory. Failing which, additional growth is obtained after pruning. Here the grower knows that the old wood does not produce new growth easily. So one should resort to grafting. Good bonsai are made quite frequently by grafting new growth on old, strong trunk.

Conventional technique

If you are fortunate you may find a naturally stunted tree on a mountain or tropical forest. Many growers think these natural dwarfs are the finest. You may begin also by rooting a cutting from a fully grown tree or by buying a young tree from nursery. In either case bonsai training does not begin until the tree has a good strong stem. An instant method is to buy a fully trained nicely shaped tree. You will, however, have the fullest control over the training of your bonsai if you grow it from seed. The basic training is done in the first four years.

First year, sow the seed in a pot containing seed compost. Keep the soil moist at all times. Transplant the seedling into a 10 cm pot containing potting compost. (Fig. 18)

Second year, pot the seedling into a 15 cm pot. Unless you are making an upright bonsai, start training the seedling. In case you want to obtain a slanting style, insert a cane into the compost at an angle of forty-five degrees, then secure the stem to it. For the cascade and semi-cascade styles, twist a piece of soft wire around the stem. Bend the seedling over until the tip is level with the soil, then attach the end of the wire to a piece of string tied around the pot.

Third year, remove the wire from the plant. The stem is now permanently set at an angle. Cut the stem back to about 15 cm in winter in case of deciduous plants or in rainy season in evergreen plants from the base. Side shoots develop alongwith stem during the year.

Fourth year, remove the tree from its container. Some of the roots are thick and others fibrous. Rigorously cut back the thick tap roots. Repot in a 10 cm pot. Bearing in mind the final shape, cut off some side shoots. If necessary trim those which you have thought to keep. To produce a gnarled impression, wrap wire around the side

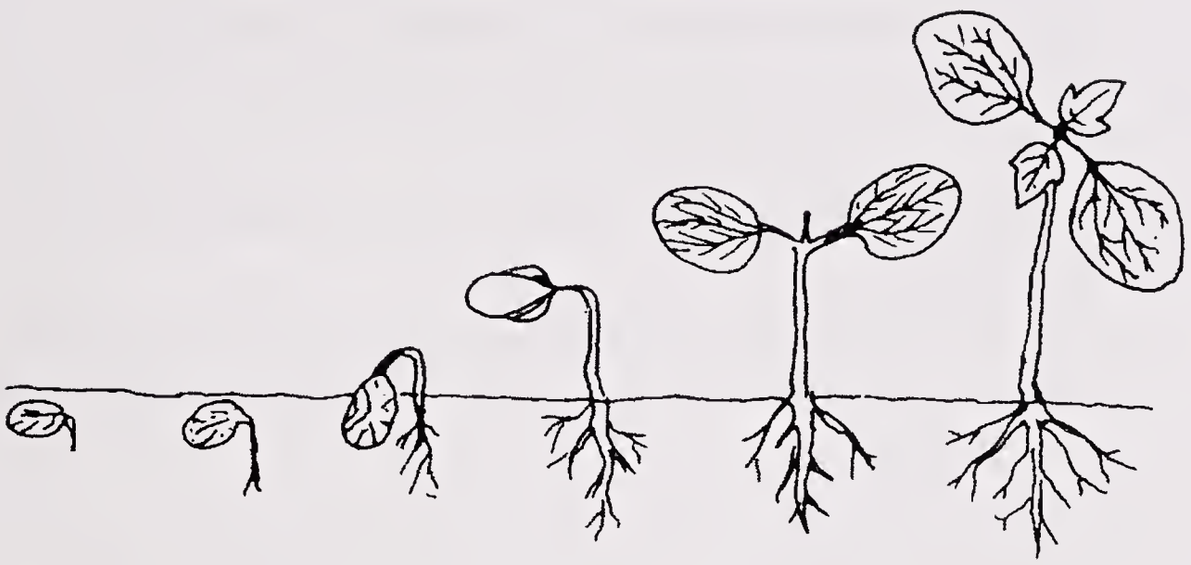


Fig. 18 *Gradual stages in the germination of a seed from the production of the first root, to the development of the true leaves.*

shoots and bend them into the desired shape. Attach the end of the wire to a piece of string tied around the container. The wire may be taken out after a year or so.

By the time a bonsai tree is five year old its shape has been established and it is time to move it to a shallow bonsai pot.

Modified technique

In this technique, the miniature trees are grown in a natural way in perfect and naturally healthy conditions. The miniature trees are built up from bottom to top, step by step. The trees are adjusted to their natural habit of growth.

This provides a tree of the shape exactly in accordance with the aims of the grower. The system stimulates the rapid growth. The degree of dwarfing of the leaves may be more than 1/100 of the original size in case of species with large leaves. In conventional system 1/10 is considered the ultimate amount of reduction. The system is based on friendship with nature. No force is used to achieve the dwarfing effect.

The main advantages are as under :-

1. The plant is trained using green shoots only. No scars are left on the branches.
2. The tree becomes dwarf while it is quite young and is not mature.
3. The dwarfing effect is not achieved by-root pruning. The roots are pruned only when the plant is shifted to the container.
4. The growth of the trunk, roots, and shoots are in harmony with each other because the tree is trained right from its early childhood.

In modified method, the plants are raised with the help of seeds. The seeds germinate quite easily in many cases. In mango and tamarind, the seed coats consist of two layers or integuments united or free, the outer being called testa and the inner tegmen and are provided with hilum (representing the point of attachment with the stalk), micropyle (a minute opening above the hilum) and raphe (a ridge formed by the stalk in many seeds). The embryo has two fleshy cotyledons laden with food material. The pointed end is called radicle and the leafy end the plumule. When the seed germinates, the radicle give rise to roots and the plumule to the shoots.

In papaw and custard-apple, the endosperm is the fleshy food storage tissue. The embryo lies embedded in the endosperm. Some seeds are best sown immediately after ripening e.g., citrus and mango whereas some seeds need a dormant period like rose. Some seeds have a double dormancy and need a cold spell before they germinate.

The process by which the dormant embryo wakes up, grows out of the seed coat and establishes itself as a seedling is called germination. The embryo grows up by absorbing food material stored up in the cotyledons or in the endosperm when it is present.

Understanding and Treating Seed Planting and their Problems

Observations	Possible Reasons	Suggested Actions
Failure to emerge Seed did not germinate	Environment, old or nonviable seed	Investigate environment, try germination test, look for other seeds
Seed missing	Insects, small mammals, or birds	Plant again, try giving more protection birds scaring, container planting
Seed germinated and grew but did not reach soil surface to emerge	Planted too shallow or two deeply, did not get enough moisture, got too hot	Plant again deeper or shallower, water more ofte, mulch
Seed germinated and grew curled up under soil surface	Soil crust too hard	Add organic matter and sand to improve soil qulity around seeds
Seed or seedling dead, normal roots with chew marks or clean cuts, parts of seedling missing	Ants beetle Iarvae and other insects	Plant again, try using container. Look for insects
Pre-emergent seedling dead; dark, soft, lesions and dark root	Pre-emergence damping-off (fungus)	Add organic matter and sand to improve drainage, use container with fresh soil
Spindly, pale seedling	Insufficient sunlight	Increase exposure to sunlight remove surface, mulch
Seedling deformed abnormal	Damaged or infected seeds	Do germination test to check viability, find new source of seeds

The following external conditions are necessary for seed germination : Water, Moderate temperature and Oxygen. The seed coat may be hard in some seeds e.g., date-palm. It is to be slightly broken to facilitate the process of germination.

The seeds should never be sown in clay. A soil mixture which is rather on the sandy side is pretty good. Cover the seeds with a layer of the compost only as thick as the seed in diameter. The moisture should be kept as constant as possible, neither too wet nor too dry. The same principle applies to the temperature. It should be kept as constant as possible, never too hot or cool. All seeds do better with the temperature a little on the warm side, about 24-28 ° C. The actual process of germination needs no light whatsoever.

Growing in container

The container is used only to establish the miniature tree. Anything like box, tin, earthen or plastic container or a bed in the open, lined with plastic sheet can be used as a container. When plastic bags or containers are used, they should be black in colour to protect the soil from light.

It is better to have some holes in the container for the purpose of drainage. If the diameter of the hole is more than 12 mm, a piece of broken earthen pot or acrylic fibre gauge is placed over it. The container should have greatest width at the top. The greater width either at the bottom or middle of the container presents problems during repotting.

The size of the container and the volume of the soil should be at least in direct relation to the final volume of the tree you wish to achieve, for example it may be 1:1. If you wish to have a tree of about one square foot in areas, the soil should be at least one square foot as well. More soil provides a better, quick and even growth. The root system is limited to facilitate transfer later on in a shallow pot.

Starting a miniature tree

The ideal time to start a plant for a container tree is one that has just produced the first true leaves after the cotyledons. For species with alternate or paired leaves, the plant may be 3-6 cm tall. At this stage the majority of seedling exhibit the same root formation irrespective of species. The plants which show an extended tap root also have at the early stage, a few capillary roots. This is a right stage when we can start our training of the plant. The seedling is taken out of the pot. The roots are shaken off carefully to remove the soil. From now until re-planting, the roots should not be allowed to become dry by sun or wind. The growing tip of every single root is stopped at this stage. As a result of this action the plant will produce laterals. By this technique a denser root system close around the trunk is obtained.

Callistermon lanceolatus
Golden Bottle brush

The seedling now is kept in the shade until new leaves have developed. After 4-5 days the plant can be brought into full sunshine.

Developing top growth

Now this is the right time for sculpturing. We must make our mind about the height and shape of the future tree. First of all we allow the seedling to grow to the height at which it has the number of leaves required for main branches. If the space between two branches is

Fig. 19 *Training of a single-trunked forest. The above figure indicates that the seedling is trained horizontally either by tying or by using a board and weight on it. The board is moved along as the seedling grows on. In the lower figures seven main branches are being vertically trained to become individual trunks.*

closer, the seedlings are allowed to grow to a height at which it has not only the requisite number of leaves, but leaves at the right points as well. The latter applies for a tree with the lowest branch appearing higher than 12 cm. (Fig. 19)

Now remove the growing tip, meaning stopping the seedling just above the highest leaf. This provides us the position of the highest main branch in due course.

Whenever a growing tip from a shoot is removed, the plant does not grow in its original direction, usually vertical. As a result of this the dormant buds in the leaf-axils are stimulated and produce new shoots. The ultimate result of stopping is a seedling with a vertical stem and laterals appearing from the sides at all points where there was a leaf. It is the result of removing apical dominance. Growth in flowering plants is restricted to definite regions. These regions are called meristems. Since the growth takes place mainly in the apical regions (shoot and root tips), the meristems are termed as apical meristems. The meristematic tissues is capable of undergoing continuous division of its cells. These cells then get differentiated into various other kinds of tissues or cells for the working of the plant.

Growth is also under the influence of chemical substances called auxins produced at the root and shoot tip. They suppress the growth in the lateral buds. In other words, while the main apical meristem is active it retards the activity of the more recently created lateral meristem. This phenomenon is known as apical dominance. For example, if the tips of the shoots are removed, the lateral buds then begin active growth. This is most commonly seen in trees that have been lopped and this is why it is possible to grow dense hedges with many lateral branches by removing the terminal buds at regular intervals.

If you are aiming at a taller tree, and you want to retain more leaves than the number of main branches

required, you may now remove all unwanted shoots. It also applies for species with leaves in pairs. The unwanted shoot must be removed at the earliest opportunity. It can be when the new shoot develops in the leaf-axil. When the new shoots have produced their first leaves, the old leaves of the first stage are removed.

Now we have the basic constituents of our future tree, the trunk and the main branches. From now on the technique is repeated on every shoot. New laterals are allowed to grow until they have the number of leaves required for these laterals or until the leaves are at the position where laterals in the next stage are wanted. The shoot is stopped then, like the previous one, above the last leaf. The result is the same as before.

New shoots appear at all the leaf-axils and are presented with a structure which resembles a tree. When the first leaves on these latest new shoots have appeared, the older leaves of the previous stage can be removed.

Phyllanthus nivosus
(Breynia nivosus)

Now we are in the third stage. The tree shows the trunk, the main branches and the laterals in the first degree for bringing out the laterals in the second and any further degree, proceed exactly as in the last two stages.

You may decide where you densify the structure with the production of more branches. You may also gain height or drop the lines. In case you want to reduce the height simply remove shoots which are pointing upwards. The' leaves pointing down are allowed to grow. There is a very important rule : never allow a shoot to grow more in any direction than you actually require. The long straight lines are not graceful. The diversion from the straight line shows age to the eyes.

Enlarging growing season

The length of the growing season influences the rate of speed of sculpturing with living material. This is because it is only during the warm periods that a plant puts growth. This growth is required for shaping. In cold climate the plants can be kept in an ordinary plastic house. Alternatively polythene sheets can be used for making a tent like structure. This may provide some warm climate. In tropical and subtropical climate similar structures can be used when climate is not friendly. We may also provide exhaust fans and evaporative cooling systems. Sufficient aeration in these plastic houses is important. The air should gently circulate.

Dwarfing rapidly

Cypress, juniper and pine are very good material for this method. The procedure is just like cutting a hedge. The training is started when the seedling has obtained about half the height envisaged. Now begin to cut back all the shoots to the shape of a little pyramid. The size of the pyramid can increase slowly adding layer after layer in the course of time the shoots will double and treble as you

want. The plant gets the shape of pyramid with dense foliage. The root pruning is done as stated earlier in this technique. The tree can be planted in the pot when the density of the foliage is achieved.

Some trees have needle like leaves, for example Indian pine *(Pinus longifolia)*, Himalayan spruce *(Picea smithiana)*, *fir (Abies webbiana)* and casuarina *(Casurina equisetifolia)*. Considering a rule, these plants produce new shoots only close to the cut which has stopped a shoot. The new shoots never appear from all the remaining leaf axils. Therefore, a different method of building-up is required for these plants.

Juniperus procumbens

The forking is important for these plants. The number of leaves or the needles are not counted. The seedling is stopped at a point when it had obtained the height where we require the first and the lowest branch, if you desire a trunk with a length of 12 cm to the lowest main branch the seedling should be stopped just above this point.

As a result of this stopping, the dormant buds in the leaf axils closest to cut are activated into growth, and new shoots appear. The number varies with the kind of plants, it can be upto five in case of some pine species. Every seedling in a normal condition may produce two to three new shoots, and in some cases even one or two from the lower area of the stem. In case you see more than two new branches at the top, remove the excess as soon as you recognize them. Of the two remaining shoots, one is adopted to be the lowest main branch while the other becomes the leader, the trunk.

For the next stopping, the desired point for branching is very important for stopping. Since one line is meant to be the trunk, you may let it grow a little longer than the other one, which is the lowest main branch. After stopping at the desired height, you may allow only two shoots to form a fork.

For stopping of these new shoots, the distance should affect your decision, although you should remember that the lowest part that you are allowing is already a branch, and the other can be shaped as two main branches or one main branch and the trunk. You should remember that it is the length of the parts in relation to each other that provide each tree its individuality.

When conifers are to be stopped, pruning is never done as a real cut. In these cases green material is separated from the growing tip from the supporting stem without damaging any of the needles.

Second root-pruning

The first root-pruning is practised on a very young seedling, when it has developed two or three leaves. It is then transferred in the growing pot, when the plant has enough space to develop the root system.

In the first year, the second root-pruning is done either in rainy season in case of evergreen plants or in winter in case of deciduous plants. At this stage the plants of most cultivated trees show a good root formation.

On top, around the trunk, a dense system of thin roots is visible. The thin roots have the ability to feed the plant. Their thin roots have grown as a direct result of first root stopping while they were still seedlings. Secondly, we also see five to ten roots, slightly thicker, developing from within the cluster of fine roots at the base of the seedling. It grows almost vertically down towards the base of the container. These roots rarely develop a split-up formation on their upper parts. The laterals are formed only when they reach the bottom of the pot. But in some vigorous plants a second lower ball of roots can be seen. It can be as the upper one.

In case the ball of roots on top can hold the soil together, we can remove all the long, string-like roots. To achieve this, turn the root-ball upside down and remove

Ficus virens

these long roots off as far as possible, but leave the portion from which laterals have developed. All the other finer roots are reduced in length by one-third. If the plant shows a dense root-ball on top, simply reduce the ball by one-third. Just remove one-third all round including the underside. We should remember that every root should have been stopped at the time of replanting. It means that the growing tip should have been removed from every end.

Precautions in replanting

It is very important to have fresh compost to about one-third of the capacity of the container. The reduced ball is then placed into the container in the desired position. Now the space round the root-ball is again filled in with this compost. With gentle tapping of the container, the compost can be firmed into place. You may also put little pressure at this time. After this, a thorough irrigation is necessary. You may use a fine spray, until the water starts coming out of the drainage holes. A better way of watering is to place the pot in a bowl of water and submerge it. You may require three to four minutes for this activity. All air bubbles may rise to the top and when they have ceased to appear, the act of watering is over because now the ball is thoroughly wet. You should remember that at this point the soil must be fully saturated. After transplanting, sunlight may be avoided as in many cases it can be very harmful for the plant. The rule is to keep the plant in the shade until it produces fresh green growth. Then provide more and more sun, gradually.

Further root pruning

The next root pruning is done either in rainy season or in winter depending upon kind of species. We take the tree together with all the soil held by the root system,'out of the pot. Now remove one third of the volume from the

base and the sides, and then turn the root-ball upside down and remove all the thicker roots further back still. These thick roots are not needed for the tree. The thick roots create hindrance when we finally transfer it to a shallow pot. However, we can allow the thicker roots to develop out of the trunk at the surface of the soil, or close to the surface and these are removed in such a manner that their length is one-third less than the final length required for the tree. These roots are exposed at the point where they leave the trunk. While replanting the tree in the pot, gently spread the root out again so that they grow as naturally as possible towards the sides.

From now onwards, we should root-prune the trees according to the species in the same manner.

Selecting right container

The container must be a harmonious part of the whole planting. The right pot disappears - it is not particularly

Ficus retusa

noticed when you are seeing the tree. Earlier, the bonsai plant was mainly meant to show off the potter's finest work. But now the trend has changed. Today, glazed pots are most often used for fruiting, flowering and other deciduous trees. Evergreen trees appear elegant with unglazed containers in dark colours as brown, red brown, grey, and dull purple. You can utilise glazed pots with deciduous trees. Remember not to overpower the tree with the container. You should select darker shades for plants with dark, rich foliage, lighter shades for plants with light foliage.

The shape and size of the pot is again very important. We should remember the principle of harmony between the tree and the container. For cascade-style bonsai, take round or equilateral pots that are several centimetres deep in order to maintain a feeling of balance with the plant. For upright and group styles, you may prefer round, rectangular or oval container. The depth of the pot is usually the same as the thickness of the base of the trunk. If you are having a group planting the depth of the pot should equal the base of the thickest trunk. The length of pot for single upright plant can be around 2/3 the height of the tree. The length of a pot for a group planting may be about 1/3 the height of the highest tree. For the multiple-trunk style, the length of the pot is around 2/3 the height of the highest trunk.

A dwarfing effect can also be produced with the selection of a right container. The more space all around, the smaller the tree appears to be. In general the shallow pots indicate a straight side to the front. But a deep container may show either a straight side or a corner to the front. A deep hexagonal container always indicates a corner to the front. Finally it is your aesthetic judgment that you have to depend on in selecting a final container.

Casuarina equisetifolia

Transferring into display pot

When we are happy with the appearance of the tree, it can be transferred into a correct bonsai pot. The tree should have reached the stage at which we do not require vigorous growth any more. The root-ball should fit into the bonsai pot, and a layer of fresh compost can be placed at the base of the pot. Some space is left at the top for watering.

LOOKING AFTER A BONSAI

Watering and Feeding

Giving the plant the water it needs—not too little and not too much—is entirely your responsibility. Most growers over water the plant to be on the safe side. In fact it is not safe. To understand why it is so, you should understand the basic activities taking place inside the pot. The pot contains roots and soil, or compost, and also air and water which together make up about half the bulk of the "soil". The more water there is between the solid particles of the soil the less space there is for air, and without oxygen the root hairs do not take up the water and mineral salts required. If the soil is always saturated with water the root hairs are deprived of air. Now the root hairs may rot and slowly the plant will die.

You should avoid watering it less as too little water may wet only the surface of the soil. The rhythm of watering should be to allow the soil to become fairly dry and then to wet it thoroughly. The leaves may wilt when the plant is seriously short of water. It is dangerous to wait for this sign. The rescue may come too late. Serious disturbances have already taken place in the life of the plant.

The wisest course is to take a look at your bonsai regularly. If the surface of the soil looks dry, feel below the surface with your fingers. With some practice this can become a reliable method. It is less time consuming than using a moisture meter. If the soil is dry all the way through then provide water thoroughly.

Ficus virens

The plants need more water when they are producing new leaves or when they are giving buds. In cold weather the growth is restricted. The soil can be allowed to become partly dry. The nice wetting is obtained by immersing the pot in a bucket of water. The bubbles rise as the water enters into the space between the soil and pushes out the air. When the bubbles stop, remove the pot from the bucket and put it somewhere to drain.

As the water goes out new air is sucked back in, and even more is slowly drawn in as the water is utilised by the plant or evaporates. When immersion watering is not comfortable, a watering-can with a narrow spout may be used. There should be 2 cm of space between the top of the soil and the rim of the pot. Now this space may be

filled with water. Stop watering when water comes out of the drainage hole located at the bottom of the pot. Do not leave the pot standing in water in a bucket or dish. You should empty the extra almost immediately otherwise aeration will be hampered.

You should be careful about knowing the quality of water that is being applied to the bonsai. The water may contain lime and it makes the water alkaline. Degrees of acidity and alkalinity can be known by a pH value - a pH of 7 is neutral, below 7 is acid and above 7 is alkaline. You can know the pH easily by using a simple paper indicator with a colour scale.

The plants growing in plastic pots require less frequent watering than those in the porous clay pots because there is no evaporation through the sides. The requirement of water is more in the soil mixture with greater amount of coarse sand because it dries out far more quickly than a loamy soil compost.

Danger signs in watering

Too little water	Too much water
• Leaves become wilted and limp rapidly.	• Leaves develop soft, rotten patches on their surface.
• Leaf growth slows down.	• Leaf growth is poor.
• Lower leaves become curled or yellow in colour.	• Leaf tips become brown.
• Lower leaves fall prematurely or turn yellow in colour.	• Leaves become curled,
• Leaf edges become brown and dried-out.	• Flowers become mouldy and may drop.
	• Young and old leaves fall at the same time.
• Flowers fade and fall quickly.	• Roots rot away.

Apart from water, bonsai need nutrients. Watering and nutrients are intimately connected because the root hairs of the plants absorb the nutrients in solution. Bonsai are as likely to be as overfed as they are overwatered, although with less disastrous results.

Gross feeding of those bonsai plants which are cultivated for their flowers encourages the growth of leaves at the expense of the flowers. On the other hand, some feeding is required. Since the plants are cultivated in pots the roots cannot extend in search of new nutrients.

There is probably enough reserve in the pot to last for four months after you have potted the plant. Little if any feeding is needed for most plants upto this period as stated above after repotting. Fast-growing plants, however, may need feeding after two months of repotting. No feeding is done when the plant is resting. It is the leaf fall period. It may be mostly in winter. During the remaining part of the year feeding after every fifteen days is often recommended. Feeding should be carried out during period of luxuriant growth. Never feed a sickly plant as it is struggling to absorb the nutrients already available in the pot. Never use large amounts or feed more frequently than the recommendations made for the nutrients. It is always better to use little less quantity as mentioned for nutrients. Fertilizer can be given as a powder pill or liquid. Solutions are taken up more quickly. The pill and powder takes more time for absorption. Foliar feeds - that is, chemical dissolved in water and sprayed on the leaves - act faster. They are immediately absorbed by the leaves through stomata.

Signs of a hungry plant

A hungry plant has an unhealthy "washed-out" look. Hunger signs are very slow to develop e.g., weak stems, small, pale or yellowing leaves, lower leaves falling before they should, and few or no flowers. Ideally, plants should

not be allowed to reach extremes before you notice that they need feeding.

Feeding checklist

Too little fertilizer	Too much fertilizer
• Slow growth, with little resistance to disease or attack by pests.	• Wilted or malformed leaves.
• Pale leaves, sometimes with yellow spotting.	• White crust on clay pots and over the surface of the potting mixture.
• Flowers may be small, poorly coloured or absent.	• Growth is lanky or stunted.
• Weak stems and lower leaves dropped early.	• Leaves may have brown spots and scorched margins.

Feeding guidelines

* Fertilizer is not a medicine for an ailing plant, frequent feeding only makes matters worse. If a plant looks unhealthy, check it for possible causes, including pest, disease and nematodes, before applying the fertilizer.
* Overfeeding can do as much damage as underfeeding. Feed only the strength (or much less) as recommended on the label.
* Feed no more frequently than recommended on the label.

Types of fertiliser

Fertilizers are available in many different forms: as liquids, soluble powders and crystals, pills or tablets. Liquid fertilizers, available in concentrated form, are very convenient, as the bottles are easy to store and the

Morus alba (Mulberry)
roots over the rock

contents need only to be diluted with water. Water soluble powder and crystals are also simple to handle. But they need a complete stirring in the prescribed amount of water to be dissolved completely. In the market slow-release fertilizers are also available. They work over a period of two to six months, slowly releasing their stored minerals. Their disadvantage is that they may produce hot-spots concentration of food around the pill. It may burn nearby roots. There are also foliage feeds: fertilizers that are diluted with water and then sprayed on to the leaves of plants. Foliar feeds produce an immediate tonic effect on any plant which appears starved.

Chemical fertilizers contain high concentrations of a limited variety of nutrients in simple chemical compounds, compared with organic matter which has

lower concentrations of a wider variety of nutrients in much more complex chemical compounds. Chemical fertilizers are relatively expensive and their supply is beyond the control of the bonsai grower. Chemical fertilizers can also have a bad effect on soil quality. The high concentrations of nutrients in chemical fertilizers encourage rapid plant growth using up the organic matter in the pot soil if the organic matter is not replenished, the pot soil structure will be destroyed. Bonsai growers who

Ficus benghalensis (16 years)

recycle garden and kitchen refuse do not need to use chemical fertilizers.

Grades or nutrient content of fertilizers are usually given as percentage by weight of their elemental nitrogen (N), phosphorus pentoxide (P2 O5) and potassium oxide (K2 O) content. However, fertilizers are commonly manufactured to include other nutrients such as sulfur and the effect of a given macronutrient fertilizer may actually be a response to another component of the fertilizer which is the limiting nutrient in the soil.

Because the nutrient content is so high compared to organic fertilizers, chemical fertilizers can create an excess of a particular nutrient, upsetting the balance of nutrients in the soil. This makes it impossible for plants to take up the needed amount of another nutrient; this condition is referred to as an induced deficiency.

Advantages of organic matter

Organic matter is a high-quality, low-cost resource for maintaining bonsai soil fertility. It provides the following benefits as it decomposes to humus :

- Is the source of 90-95% of soil nitrogen, including that which is cycled through microorganisms. When it makes up more than 2% of soil, it can be the major source of available phosphorus and sulfur.
- Is a major source of the cements necessary for aggregate formation to create strong soil structure with a higher proportion of larger pores, which improves water-holding capacity and water and air movement.
- May furnish 30-70% of the negatively charged sites that hold nutrient cations plants can use. This electrical property also gives organic matter the ability to act as a buffering agent, moderating the tendency to change pH when acid or alkaline substance are added to the soil.

- Acts as a chelate, that is, it forms compounds with metal nutrients (usually iron, zinc, copper, or manganese) increasing their solubility and availability to plants.
- Acts as a mulch on the soil surface.

Composts

In the garden a plant grows in soil, which receives manure and fertilizers. But a bonsai in a small potful of soil and nutrients are quickly exhausted. The open quick-draining structure of the soil disappears due to artificial conditions in which a bonsai plant grows. It is, therefore,

Ficus glomerata

best to use artificially concocted "soil". Some kind of composts are mentioned below.

The basic potting compost can be made up from the following materials. These materials must be measured by bulk and mixed thoroughly :

8 parts damp, sterilized loam
4 parts damp, leaf mould
1 part coarse sand

Now a base is made by adding fertilizers, measured by weight to the above potting compost :

2 parts bone meal, or dried blood
2 parts superphosphate
1 part potassium sulphate

This is the fertilizer base and now it is added to the compost in varying strengths. This may also depend on your experience. One kind of resulting mixture can be as under :

120 gm. Base
20 gm. Ground chalk or ground lime stone
30 Kg. compost

This mixture is good for plants in a small pot upto 10 cm. You can also prepare another potting compost mixture as under :

230 gm. Base

15 gm. chalk. It is added if the reaction of the compost is acidic.

30 Kg. compost

This mixture may be suitable for mature bonsai. For pines and palms a special compost is made as under :

4 parts loam

4 parts leaf mould
2 parts manure
1 part compost
2 parts sand

For Ficus species the special compost can be made as under:

4 parts loam
3 parts leaf mould
2 parts dried manure
1 part coarse sand

As you pot, mix a good sprinkling of superphosphate into the compost. You can forget all about composts and soils if you grow your bonsai plants hydroponically. By this method the minerals which the plant normally obtains from the soil are fed directly to the roots in a carefully formulated solution of mineral salts in water. The soil is not necessary for growth. It is the correct quantity and proportion of nutrients that is necessary. The plants require sixteen elements for its growth, flowering and fruiting. Since plants cannot just float on the water, some method of anchoring their roots has been devised. In the first method pebbles, little sand, charcoal and a watertight container is used. The choice of the container depends on your imagination and taste. Put a few pieces of charcoal at the bottom of a bowl, cover them with a thin layer of sand. Keep a layer of pebbles on top of this. There are good proprietary fertilizers available for this purpose in many countries. It is not necessary to prepare your own. In Europe and in the United States special hydropots, are quite popular.

The above list includes the names of thirteen elements. Carbon, hydrogen and oxygen are the other three elements, thus completing the list of sixteen elements. The sixteen elements are required for the completion of life cycle of a plant.

Role of mineral elements in plant nutrition

Nutrient element	Function in Plants	Losses from Pot
Nitrogen (N)	Manufacture of chlorophyll. Active leaf and shoot growth.	Leaching, crop removal
Phosphorus (P)	Healthy root production. Flower bud production.	Crop removal, fixation in soil Revertion to unavailable form in soil
Potassium (K)	Healthy formation of leaves flower and fruit production	Crop removal. Soil fixation, leaching
Calcium (Ca)	Cell walls, cell growth and division; nitrogen assimilation.	Leaching, plant removal
Magnesium (Mg)	Essential in chlorophyll, formation of amino acids and vitamins. Aids in seed germination.	Leaching, plant removal.
Sulphur (S)	Essential ingredient in amino acids and vitamins.	Leaching, crop removal
Boron (B)	Affects flowering, pollen germination, fruiting, cell division, water relatins, hormone movement.	Crop removal, leaching
Copper (Cu)	Constituent in enzymes, chlorophyll synthesis, Catalyst for respiration, carbohydrate and protein metabolism	Tie-up by highly organic soils and acid soils. leaching
Chlorine (CI)	Not too much known except that it aids in root and shoot growth.	Never deficient in pot conditions.
Iron (Fe)	Catalyst in synthesis of chlorophyll	Crop removal, leaching and erosion. Unavailable in alkaline pot soils.
Manganese (Mn)	Chlorophyll synthesis.	May be unavailable in alkaline soil. Toxic in acid pot soils.
Molybdenum (Mo)	Essential in some enzyme systems. Protein synthesis.	May have been lacking when soil was formed or become unavailable
Zinc (Zn)	Used in formation of auxins, (hormones), chloroplast and starch.	May not be available in alkaline soils; and toxic in acid soils. Crop removal.

Average per cent of mineral elements

The percentage of mineral elements on dry weight basis in a bonsai are :

Carbon 45, Oxygen 46, Hydrogen 5, Nitrogen 1.5, Potassium 1.0, Calcium 0.4, Magnesium 0.2, Phosphorus 0.2, Sulphur 0.1, Chlorine 0.1, Iron 0.01, Manganese 0.004, Boron 0.003, Zinc 0.003, Copper 0.0001, Molybdenum 0.0001.

Useful additives

Humus (leaf mould) : Retains nutrients and gives an open texture.

Manure : Used as a dried power, cow manure is nutrient rich.

Peat moss : Holds water and added fertilizer very well.
Tree bark : Holds water and added fertilizer very well.

Dolomite limestone powder : Acts to reduce the acidity of potting mixtures.

Eggshell/oystershell : Reduces the acidity and assists drainage of potting mixture.

Limestone chips : Reduces the acidity and assists drainage of potting mixture.

Coarse sand: Opens up potting mixtures for better aeration and drainage.

Rockwool : Holds moisture and allows air to penetrate.
Vermiculite : Absorbs and retains nutrients and water.
Sphagnum moss : Has excellent water retaining capacity.

Charcoal : Absorbs excess minerals and waste, keeps the mixture "sweet".

Perlite : Gives potting mixture an open texture for aeration and drainage.

Nutrient deficiencies

Plants exhibit shortage of plant food through certain well recognized visual deficiency symptoms, as mentioned below:

Element	Deficiency symptoms	Treatment		
		Mineral	Soil application (gm/sq. mt.)	Foliar application (gm/1)
1	2	3	4	5
Nitrogen	Stunted growth, pale yellow appearance, bottom leaves start burning from tips and margins, pre-shedding of leaves	Urea	8 to 10	1 to 5
Phosphorus	Restricted root development, deep green foliage, delayed maturity, poor seed and fruit development. In acute deficiency purple leaves and stems are formed.	Diammo-nium phosphate	30 to 40	20
Potassium	Marginal scorching of leaves, shrivelled fruits and seeds, plants lodge easily, reduced fruit size and quality.	Potassium sulphate	50 to 60	20
Calcium	Drying up of growing points, under acute deficiency premature shedding of flower buds and fruits. Margins of young leaves curve or curl backwards or forward, weak stem.	Calcium carbonate	150 to 160	-
Magnesium	Loss of colour of leaves at tips and between veins from older leaves, upward curling of leaves, twigs, prone to diseases.	Calcium nitrate Magnesium sulphate	- 200 to 250	6 to 8 10 to 20

1	2	3	4	5
Sulphur	Yellowish leaves, old leaves show necrosis at tips and margins.		Rare in occurrence	
Boron	Growing points turn pale green. Acute deficiency results in death of growing points.	Sodium Borate	1 to 2	1 to 2
Copper	Yellowish green colour in margins and tips of younger leaves giving a bleached apprearance.	Copper Sulphate	5 to 10	2 to 3+ half the quantity of hydrated lime
Iron	Chlorosis of youngest leaves, curling of leaves upward.	Ferrous Sulphate	2 to 4	2 to 4+ half the quantity of hydrated lime
Manganese	Interveinal chlorosis followed by development of spots of dead tissues in leaves which may drop.	Manganese	20 to 30	2 to 4+ half the quantity of hydrated lime
Molybdenum	Stunted plants and yellowing of old leaves.	Ammonium/ Sodium molybdate	1 to 2	0.1 to 0.5
Zinc	Interveinal chlorosis often with necrosis, terminal leaves are abnormally small referred to as little leaf/ die-back of twigs and reduced flowering.	Zinc Sulphate	2 to 4	2 to 4+ half the quantity of hydrated lime
Chlorine	Wilting of leaf tips.		Rare in occurrence	

Potting and repotting

A plant which is not confined in a container spreads its roots in search of nutrients and water in all directions. But in a bonsai the roots grow towards the sides and then turn around and around, twisting among themselves. After sometime the container is crowded with roots. The

Jumperus prostrata

nutrients are in short supply. But the plant needs to develop. At this stage, but preferably some time before, it should be repotted. In case of bonsai the term repotting may not be correct. As a matter of fact it is change of compost after proper pruning. Unfortunately, the visible signs that a plant is becoming potbound appear when the growth has been hampered. The evidence that requires immediate action is when roots appear through the drainage hole of the bonsai. The leaves may wilt soon after watering, indicating that there is not enough compost left to hold water. New leaves remain small and old leaves turn yellow and fall off because the nutrients are limited and concentrated on the growing tip of roots.

The root system in a pot depends on whether it is clay, or plastic. In a clay or earthen pot the water runs through the compost to the porous sides of the pot and the roots adopt the path of the water and only later fill the compost

in the centre of the pot. In impermeable plastic pots, the roots go downwards and then spread outwards. If the roots are obviously not crowded, put the pot back over the soil ball, turn the plant the right way up, provide the pot a sharp pressure on the table top. This will help the compost to settle back into place and no harm may have been done. Many times ceramic pots are also used. In such type of pots the movement of roots is almost like that of plastic pots.

Root pruning is an important operation at the time of repotting. It serves two functions. It keeps the root system within the bounds of the container. It also stimulates the growth of fine feeder roots. Root pruning, therefore, improves drainage and aeration. In this way the plant receives better nourishment. The finer roots do not crowd in the pot. If there is an uncrowded root system the health of the plant is better. Before repotting let the plant remain without water for a day or two. The soil becomes dry. It is easy to take out the plant along with root system from the pot. If the root system is crowded, it should be repotted. If there is good amount of breathing space between roots, everything is all right.

As stated above, this can be observed also by inspecting the edges of the soil or the drain holes in the bottom of the container at least once in a year or so. If you see many roots coming out, it is a good sign to understand that the root system is getting a little crowded.

To re-adapt an established bonsai to its pot, you should remove any surface rocks and then also take out the moss in small pieces slowly. Now the moss should be kept moist. By this technique the moss that you have taken out can be again used when you are repotting the plant. The container should be tilted or inverted. Now it should be given some pressure so that the root ball can be loosened. As stated above, you should let the plant go

without water one day before. This helps in taking out the plant from the container.

An established bonsai plant must retain some original soil in its root system. You may begin by trimming away one third of the plant's root ball soil and roots -using a knife or shears. Remember to cut the roots at about 45° downward slant. By this method roots heal much faster. After you have removed 1/3 of the plant's root ball, take a pencil and remove half the remaining soil from around the roots. While doing so, be careful not to damage remaining roots. Next remove all downward growing roots. You may try to flatten the root ball on the bottom and cut so that its final thickness is about 1/3 the height of the container.

The repotting should be done when the roots are active and able to grow quickly. You should provide a new compost. The extra nourishment now available helps the plant to recover from the shock of the change. The additional compost now added must be the same type as that in which the plant has been growing.

Signs of ill-Health in Bonsai

Symptoms	Wilts Possible reasons	Suggested remedies
Pot soil and temperature heat stress	High temperature and transpiration rates	Shade, check pot moisture
Water-saturated soil in pot	Overwatering	Reduce watering, add in pot organic matter for more open texture
LEAVES		
Many tiny insects on underside of leaves	Aphids, mites, thrips	wash off, crush, spray

Symptoms	Wilts Possible reasons	Suggested remedies
Mottled, curled, mishappen, dwarfed in particular with citrus	Viral diseases	Burn or discard plant, clean hands and tools
STEMS		
Insects holes on main stem	Stem - boring caterpillars	Remove borer
Ring of vascular browning seen in stem cross section	Fungal vascular wilt	Add organic matter, do not overwater.
Chew marks on base of stem	Caterpillars	Hand pick, especially at night, use stem collars
ROOTS		
Roots brown and soft, cortical sloughing	Fungal root rot	Add organic matter, do not overwater, add fungicide
Round knots, lesions or swellings	Nematodes	Add organic matter, use noninfested planting material, heat and dry soil
Small root system, few roots	Larvae or grubs eating roots	Change soil & kill pests

Leaf problems

Chlorosis (leaf yellowing) whole leaf (old leaves)	Nitrogen deficiency	Add high N, organic matter in the pot.
Whole leaf	Nematodes	Check roots for swellings or knots, Add organic matter, Heat soil.
Whole leaf	Fungal root rots	Check roots for browning and soft tissue, add organic

Symptoms	Wilts Possible reasons	Suggested remedies
		matter, do not overwater.
Whole leaf	Root-bound	Check roots for tangles, twisted growth, untangle roots.
Between veins of new leaves	Iron or zinc deficiency	Lower soil pH, Add iron or zinc
Veins in old leaves	Viral disease	Clean tools and hands control insect vectors.
Half of leaf and vascular browning	Fungal vascular wilts	Add organic matter, in pot.
Mottled or mosaic pattern	Viral disease	Clean tools and hands, control insect vectors.
OTHER		
Leaves unusually purple	Phosphorus deficiency	Add high phosphorus organic matter.
Black spots or rings	Fungal leaf spot	Remove and discard affected leaves, clean hands and tools.
Salt burn: edges brown, white, or yellow	High salt concentration in soil or water	Use sweet soil, check water quality
Dry, brown patches, holes visible with lens	Sucking insects	Pick off or crush, wash or spray with water and insecticide.
Chew marks on edges, small hoes in centre	Chewing insects	Pick off, wash or spray with a insecticide
White, powdery spots	Powdery mildew fungi	Spray fungicide
	Bacterial spot	Remove and destroy affected leaves, wash hands and tools

Symptoms	Wilts Possible reasons	Suggested remedies
Fruit problems		
Fruit		
Mottled yellow/green, faint yellow rings	Viral disese	If severe, remove and destroy fruit, control insect vectors.
Hard white lesions or scar on exposed part of fruit	Sunburn	Shade bonsai
Yellow spots with holes	Sucking insects	Remove, trap or crush insects, wash or spray fruit with water
Small, scablike dark spots with yellow margin	Bacterial spot	Remove and destroy affected fruit, add organic matter to pot soil.
Pomegranates; fruits crack open	Uneven or inadequate water supply	Establish regular schedule beginning just after flowring through fruit ripening
Fruit soft		
Holes in fruit, e.g., figs, peaches	Fruit beetles or boring insects	Trap and remove beetles, remove ripe rotting fruit.
Small holes on skin,	Fruit fly larvae	Cover fruit toprotect from egg laying, use home made sprays.
Holes eaten in fruit	Birds	Frighten off, cover fruit or whole plant
Abnormal growth		
STEM		
Galls or swelling on crown or higher	Crown gall bacteria	Use clean tools and hands.

Symptoms	Wilts Possible reasons	Suggested remedies
especially on stone fruits		
Swelling or holes higher on stem, dieback above these	Insect eggs	Use insecticide
Many buds	Damage from thrips, mites and other insects, may carry viral diseases	Remove and destroy affected parts, eliminate insect vectors, clean hands and tools.
Pale, internodes long and spindly	Insufficient sunlight	Gradually reduce shades
Large, dark, sunken spot at soil line	Collar rot fungi	Clean hands and tools, don't over water
LEAVES		
Misshapen, curled	Mites, disease	Remove and destroy affected parts, crush, spray insecticides.
Misshapen, dwarfed mottled, especially the new growth	Viral diseases	Clean hand and tools use disease-free stock
Misshapen dwarfed with wilt or unilateral chlorosis, vascular browning	Fungal vascular wilts	Don't over water

GETTING STARTED

The conventional way of starting a bonsai is to get a plant growing wild, pot it, and wait many years training it. This technique has already been described earlier in this book. Because there is such a long wait before training can be started, the other methods described in this chapter are accepted ways of starting bonsai. A good method is to start with a nursery plant. The technique has already been described earlier in this book.

Bonsai from seed

If you start your bonsai from seed, you will have to wait for a long time. In case you have patience, your reward is almost complete control over the shape of your plant from the very beginning. The drastic prunning is normally not necessary. You can try pomegranate, citrus, pine and oak. The best time to sow seeds for bonsai is early spring or rainy season. You should take a mixture of one part sand and one part peat moss and put seeds. The emergence of the seedling depends on the kind of plant you have taken.

Cuttings

Cuttings are useful for many plants. Examples are fig, mulberry, ficus and several other plants. The best time to take cutting is in early spring, just before brand new buds open. Mulberry is a fine example. You can take cutting in rainy season. The best cuttings are made from non-flowering side shoots of vigorous, healthy plants. If the stems naps when you bend it, it is suitable for taking

cutting. If it bends or crushes, it's either too young or too old. Jasmine roots are better from cutting with what is called "heel". This means that when you take the cutting, you will also include a little part of the older or larger branch. Remove a heel cutting from the parent plant with a very sharp knife, being careful not to harm the bark and leave a ragged cut. Trim the heel so that the edges and the sufrace of the cut are smooth. Dip the end of each cutting into some water, then into a root hormone-fungicide powder. You should follow the directions on the package label. Now set the cuttings into the sand or soil mixture, keeping at least two nodes below the surface. You should carefully firm the soil around the cuttings so that they stand upright. Keep the soil moist. The cuttings do not like waterlogged conditions. They can rot. Keep them out of direct sunlight and mist the leaves regularly. The cuttings can be well established in six months to a year. When the vigorous new growth appears, you can take it out and transfer them into pots. You should protect them from extremes of sunlight and wind until they are established themselves in their new environment.

Grafting

Grafting is the technique of joining pieces from two different plants so that they develop and grow as one plant. The stock is the part used as the base. The stock gives the root system to the new plant. The scion is the piece used as the top part of the new plant. The union between the stock and scion, each from different plants is formed from the contact of the cambium, a layer between the phloem and xylem in dicots.

Parenchyma cells are thin-walled plant cells that do many functions. They are produced in the cambium of both stock and scion to heal the graft wound. The parenchyma cells, which line up with the cambial cells of the stock and scion in the healing process, later become

Bougainvillea

new cambial cells. In turn these new cambial cells form new xylem and phloem cells, establishing connections between the vascular system of the stock and scion. This connection is only possible in dicots and is essential if the scions are to receive the water and nutrients necessray for it to survive, Grafting is limited by the compatibility of stock and scion. Indicators that a graft combination may be incompatible are :

- Failure to form a graft union.
- Yellow leaves at the end of the growing season early seasonal leaf loss in deciduous trees, slow growth.
- Differences in the growth of stock or scion.
- Premature death of bonsai.

Top grafting

Two kinds of top grafting are quite simple to do - cleft grafting and whip grafting. The stock should be about 1.25 cm in diametere where the graft is to be made. Cleft grafting is done this way.

1. Cut the stock straight across, leaving some leaves on the stem.
2. Place a grafting tool or a very sharp knife across the end of the cut and press it in with a small weight to make a cleft about 1.25 cm deep through bark.
3. You should remember that the scion should be of the same diameter as the stock. Cut its lower end into a wedge shape and insert it into the split stock. Now you should ensure that the cambium layers of the two pieces match. As stated earlier cambium is the soft layer of tissue between the bark and the wood. Leave just a little of the cut surface of the scion exposed above the surface of the stock. This makes for a stronger union. If the scion is not as thick as the stock, place it off-centre so that one outer edge is flush with the outer edge of the stock.
4. Now you should bind the graft with raffia or a grafting polythene band. You can also cover it all over with grafting wax. As a matter of fact a thorough band of polythene sheet is good enough. You may keep the grafted plant, protected from wind and direct sunlight. Watering is very important for about a month. After this you can place slowly and slowly in the direction of sunshine. Regular watering is still needed. You should watch for the new growth in the scion.

Whip grafting

In this method small scions are grafted on small stocks. It's a simple method for adding to your bonsai where an unsightly gap can not be filled by another branch.

Make a slanting cut through both the stock and the scion. Then make a second cut into each piece, starting

about one third of the distance from opposite tips, cutting almost parallel to the original cut. Now you should fit the scion and the stock together. Now wrap the union with raffia and cover it with grafting wax. Aftercare is the same as mentioned above in case of cleft grafts.

Side grafting

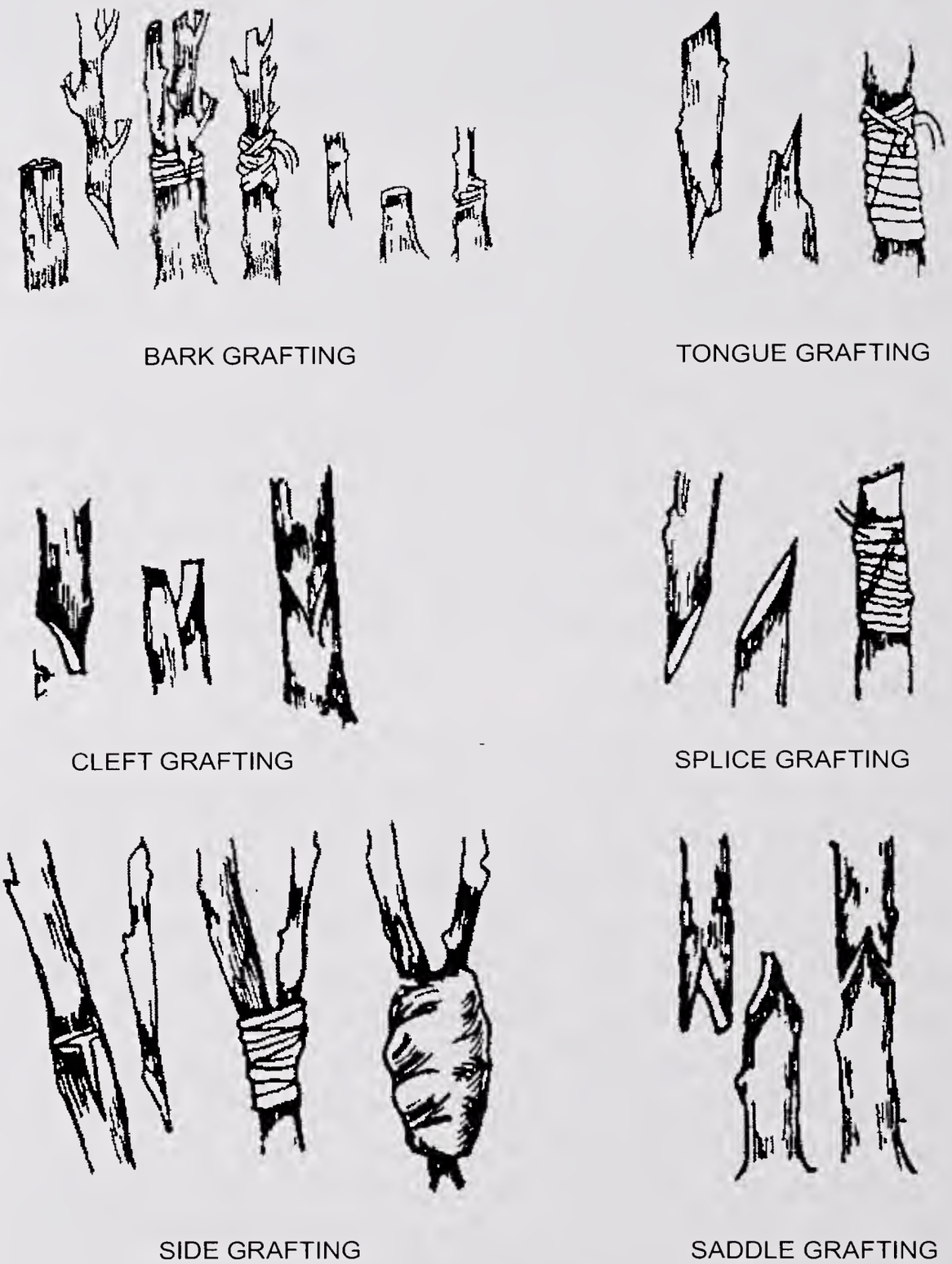
Side grafting is used with thicker stock. The thickness can be more than 2 cm. You can prepare the scion by cutting it in a wedge shape, but give the wedge unequal sides. The inner side must be longer than the outer side. You shoud make a cut in the side of the stock where the scion is to fit. Insert the scion (shorter cut down), wrap the graft with raffia, and grafting wax is used for covering it. Prune the stock pack to just a few leaves. You should take care of your graft as mentioned above. (Fig.20)

Approach grafting

This is the simplest method because the scion is not removed from its parent until the graft union has taken place. In this technique remove a piece of bark from both scion and stock with a grafting knife. You should take care not to damage the wood. Now you should press the two against each other so that the cambium layers are in contact. Now tie with raffia or a polythene sheet band. You shuld not use mastic. Contrary to popular belief, grafting mastic does not have any role in the taking of a graft. This can be proved by the fact that many grafts do not need sealing (Fig.21). The contact between cambium cells, which ensure a union, is enough with raffia binding. The addition of mastic is only required where a large portion of tissue remains exposed and needs protection from fungal problems.

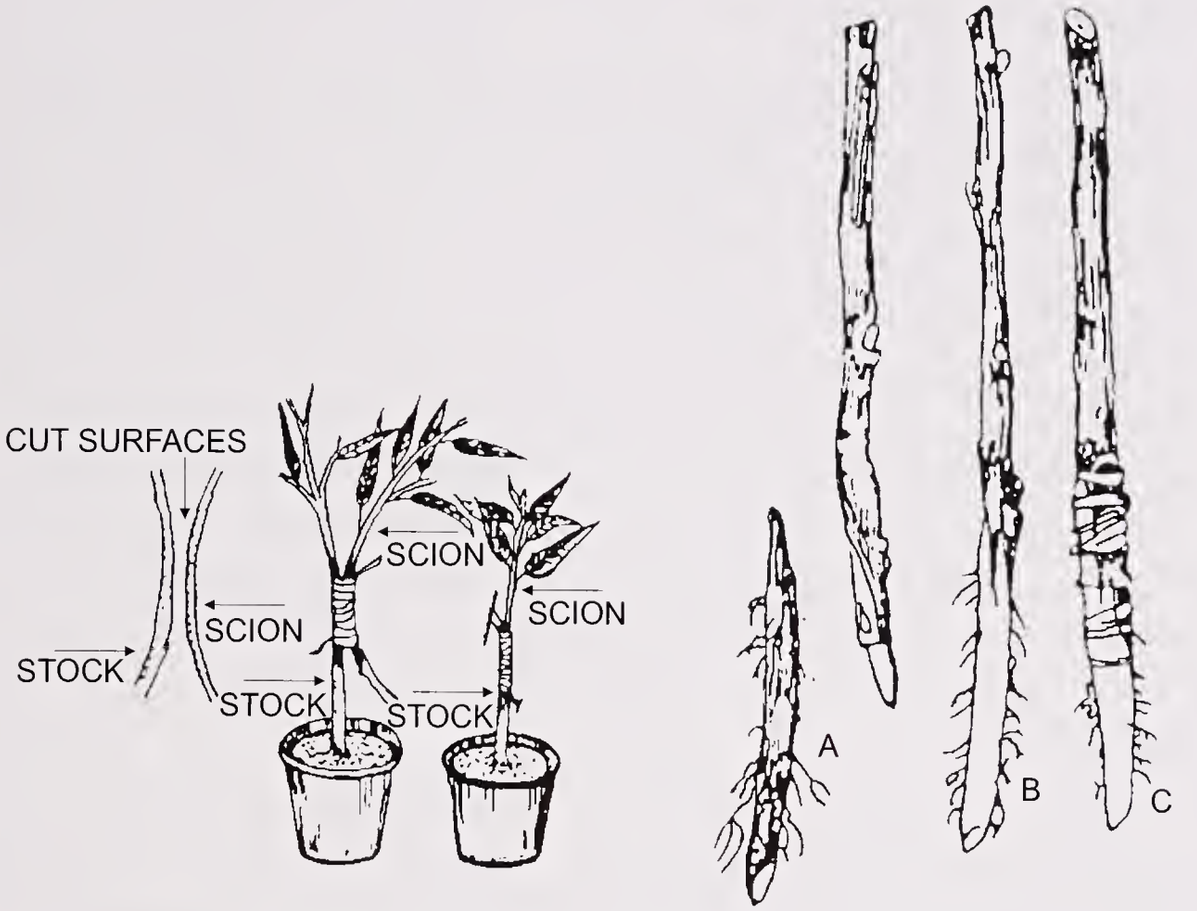
If the rings of growing tissues match perfectly, the union takes place quickly. You should do this kind of grafting when their growth is most active. In case of

GRAFTING



Fi.g. 20

mango, this can be done in March-April in north Indian conditions. When growth has taken place in the scion portion, the plants can be separated. The stock is cut above the joint. The binding can be removed. To help heal



INARCHING **Fig. 21** ROOT GRAFTING
A - Stock B - Scion
C - Grafted Stock and Scion

the scar and to make it less prominent, cover the wounds with mastic.

Apical grafting

Apical grafting is a technique in which there is no stock above the grafting point. It is used on trees such as olive, peach and citrus. In this case the scion should have several buds. Matching areas of cambial tissues on stock and scion are joined. If the stock is larger than the scion, only a portion of the cambial tissue can be joined. The graft is then tied into place with the help of a band of polythene sheet. Because of the relatively large amount of surface area exposed in this kind of graft, it is important to cover it with a protective seal.

Crown grafting

Like cleft grafting, this requires a clean cut. These slits must not be made right across the stem. Vertial slits are made in the bark in three places, 4 cm apart. Now you should cut the ends of the scions to a taper, then insert in the slits. You should use a good grafting knife for preparing the slits. In this process you should lightly peel back the bark, as well as trim the scion. Use the small spatula at the other end of the knife to peel back the bark. When the scions are in palce, unite the graft and apply mastic. This kind of graft is required for producing a broom or weeping style bonsai.

Budding

It is a popular grafting method in which a bud is grafted onto stock plant. There are many types of cuts used depending on the kind of plant and local conditions and practices.

Budding is done during periods of active growth for the stock plant, when the cambial cells are rapidly dividing. The rootstock seedling should be large enough to support a bud. The bud produces the new top. In citrus, September, October in North India is a staisfactory period. Some other trees that can be bud grafted are mango, guava, jujube and the stone fruits.

T-budding

T-budding or shield budding is one of the quickest, easiest, and most reliable budding methods. In T-budding the stock is prepared by making a vertical cut about 3 cm long through the bark and a horizontal cut, extending about one-third of the distance around the stock, intersecting the vertical cut to form a T. The scion bud is cut out by making a horizontal cut through the bark and into the wood about 2 cm above the bud. Then an upward

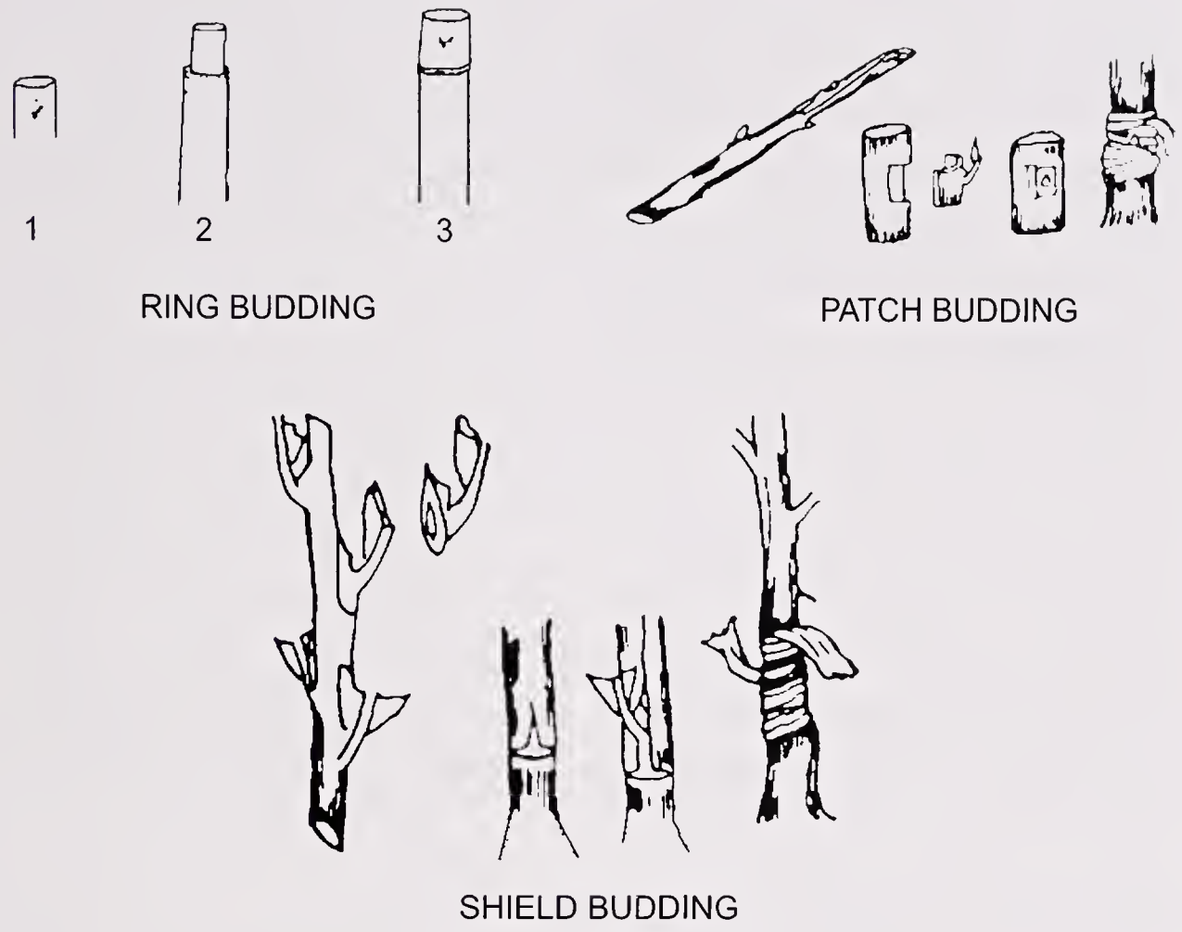


Fig. 22

slice is made to meet the horizontal cut, starting about 1.5 cm below the bud and slightly into the wood to ensure that the bud is properly inserted. This bud piece is then pushed down, under the flaps of stock bark until the horizontal upper edges of stock and scion are flush. The bud piece must fit strongly and be covered by the two flaps of bark. Then the wound is bound and tied shut, avoiding any direct pressure on the bud. You may use a band of polythene sheet.

Chip budding

Chip budding does not require separation of the bark from the stock and so can be used when the bark will not separate, for example, when the weather is dry. This method depends on the contact of two flat surfaces. The stock seedlings used are frequently still quite young. In

mango, the stock seedling is only three weeks old. The stock is prepared by making a horizontal slice below the bud that is to be removed. A second slice starting above that bud, running around and behind it, and meeting the first cut will free the piece from the stock. This piece can be composted. This exposes an area of woody tissue surrounded by cambial tissue and bard. Continuing the vertical cuts slightly below the horizontal one on the stock creates a lip of the lower end of the stock cut. A scion bud can be cut out following these same steps and must be matching with the exposed area on the stock. The scion is placed on the stock so that their cambial tissues meet perfectly with the lower lip of the stock, helping to keep the scion in place. Now it is tied and carefully wrapped with the help of a band of polythene sheet to cover all exposed cuts. (Fig. 22)

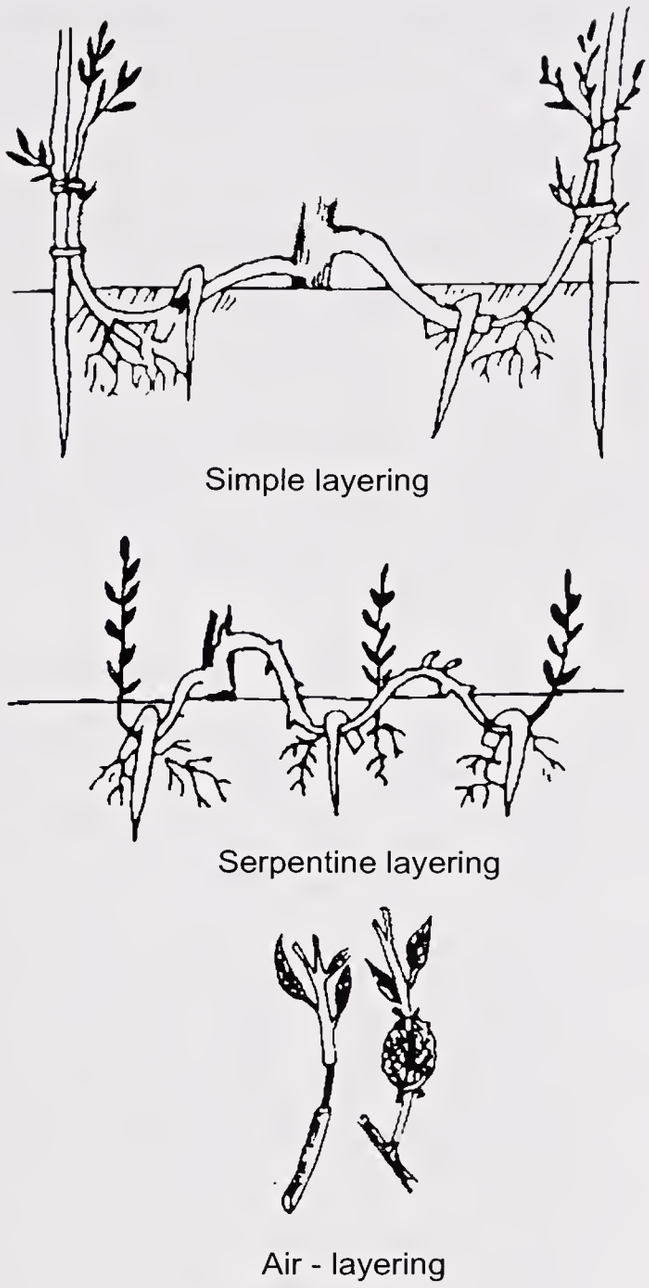
Care of budded seedling.

The budded seedling should be shaded and watered during the healing process. Tying some leaves above the grafted bud may provide a protection from the hot sun. As soon as the swelling of buds and some growth is seen - the band of polythene sheet should be removed. It may take two to four weeks. Now the focus of the plant's growth must be shifted from stock to scion.

In numerous plants a condition of apical dominance exists, that is, the top or terminal bud is the centre of growth suppressing growth in any lower buds. To overcome apical dominance, the top of the stock may be bent over or tied or pegged at a level lower than the graft. The cocuses growth on the scion while the stock is providing food until the graft is more established. Now the stock can be cut off just above the graft. Other methods are to bend and partially break the stock, or simply cut it off above the graft after some time of grafting.

Layering

It is a method of vegetative propagation that encourages the growth of adventitious roots from branches or shoots, finally giving a viable plant that may be separated from the parent and transplanted for making a bonsai. By bending, girdling or cutting, the movement of food and hormones through the phloem down to the roots is interrupted. Root development is stimulated where these substances accumulate, just above the cut or bend. The flow of water and minerals from the roots to the layered part continues through the intact xylem. Rooting is stimulated when the stem is also hidden from light by being wrapped or covered with soil. (Fig. 23)



Air -layering Fig. 23

Simple layering

For simple-layering vigorous shoots from around the parent plant's base work well, because they bend easily and root quickly. The shoots should be about one year old and sufficiently long to produce new roots far enough away from the parent that digging them out may not damage the parent's own roots. Branches may be avoided

because they are older tissue than shoots. They are stiffer to bend and slower to produce roots.

Air layering

Another kind of layering called air layering or marcottage is based on the same principles as simple layering. It is done on shoots that are not buried in soil. There are three ways for doing air layering.

1. Wrap copper wire, tie a tourniquet once around the branch about 2.5 cm below the place where you want the roots to grow.
2. Now you may use sphagnum moss that has been soaked in water. Now pack moist moss tightly around the new-root area in a ball shape. The diameter of the ball of sphagnum moss should be at least four to five times the diameter of the branch.
3. You may now wrap the moss ball with a piece of polythene sheet and tie it with string at top and bottom. You can see the growth of new roots through the polythene. This also helps you in seeing the moss which should remain moist. This method is not good for pines because the formation of a root system may take from one to three years.

Division

You can take a plant and can divide the root mass and the above-ground parts into sections and presto. One single plant may give you two or more, ready to be planted separately. Shrubs and perennials with multiple trunks (such as bamboo, pomegrante and chrysanthemum) can be divided quickly and easily. Early spring, just before new growth appears or the rainy season is the best time for dividing plants. Your experience about the growth habit of the plant may guide you about the best time for division.

1. Dig out the root mass with a spading fork and separate it into sections. Many times you may require to cut the roots apart with the help of a sharp knife.
2. You may divide pomegrante and chrysanthemum by cutting new shoots off the roots. Now you may plant the shoot separately. The length of the shoots should be around 6 to 10 cm.
3. In case you want to divide bamboo, simply cut off a 5 cm section of a mature root and plant it separately. These sections may sprout in due course of time.

Suckers

Shoots originating underground from the roots of trees like olives and jujubes are called root suckers. Drought encourages root suckers in jujube trees. You can dig up the suckers and separate during the dormant or "pregrowth" season. Now you can transplant in a pot. Often a small portion of the parent root is transplanted with them. Suckers growing from a tree which was grafted onto root stock produces plants with the same qualities as the stock, not the scion of the parent plant.

BONSAI TOOLS

To start with, you may require to have secateurs and pruning shears. In the long run, however, you shall be needing tools specially designed for bonsai. With the help of slender bonsai scissors, it is possible to reach every branch and root on your plants. You may also require pliers for removing wire. The pliers do not damage the bark, and can also make a concave incision. The wound thus produced will heal quickly, without bad scarring. The following bonsai tools are important in your work.

1. Screw-clamp for bending branches and trunks.
2. Pliers for cutting thick roots.
3. Leaf cutters.
4. Brush for cleaning and smoothing the surface of the soil.
5. Tweezers for pinching out young shoots, removing wilted leaves and aphids.
6. Wire cutters for removing wire.
7. Rake for separating out matted roots when repotting.
8. Scissors for cutting shoots, branches and thin roots.
9. Scissors for cutting fine shoots and thinning out twigs in the crown of a tree.
10. Pliers for unwinding wire on wired trees, also suitable as a jinning tool.
11. Concave-cutting pliers for cutting branches off very close to the trunk, a very important bonsai tool.
12. Saw for sawing off thick branches.

Euphorbia splendens

13. Wood chisel for gouging out a fairly large incision.
14. Anodised aluminium wire in various thicknesses.

It is essential to have tools that are efficient and well designed so that you can produce trees which conform to the aesthetics of bonsai.

●

BONSAI TRAINING

It is advisable to keep in mind a basic rule: the bonsai must look natural, that is to say, you should not forget the tree's growth pattern in the wild. Since a bonsai must appear typical of a normal tree, many bonsai growers make sketches of trees or groups of trees to provide them the final shape for their bonsai. You should always remember that nature is the model for bonsai shaping. It can not be regarded as an unnatural training. With bonsai training you are not making efforts to impose an artificial shape on your plants. A cypress can not be turned into a cascading style when you can use a juniper.

The miniaturisation of a plant depends on two factors: firstly the size of the pot which inhibits the growth and spread of root systems and consequently on the absorption of water and nutrients; secondly, the constant prunning back of shoots, twigs and roots and nipping out of shoots and buds. You can also find out miniature forms of plants in nature, where it is the environmental condition that causes the controlled growth. Even so, these plants look natural and are strong and healthy. (Fig. 24)

Plant containers

A good bonsai always indicates its roots, trunk, branches and leaves all in perfect proportion. The tree, the surface of the soil with grass grown on it, and the pot are all in balance. Bonsai that develops upright must be planted in shallow, rectangular or oval dishes. The bonsai with a cascade style should be placed in a deep, round or

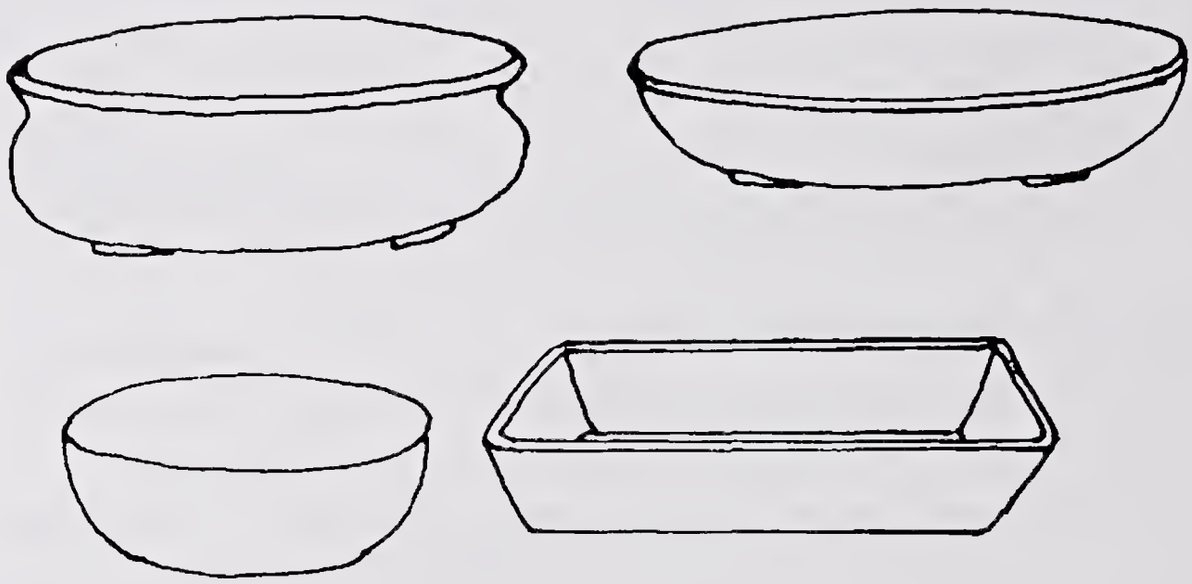
Fig. 24 *The right hand example produces a stiff and formal appearance in a container. The pot on the left gives added space and an effect of landscape.*

square dish. The shape of the dish must match the overall form of the plant. There are many trees that show a thick heavy-looking crown. Such trees should be placed in a weighty pot. The colour must be chosen in proportion to the colour of the foliage and trunk. The trees that have light-green leaves appear best with light-coloured, glazed dishes. The dark foliage fits well in shades of dark red, grey or brown. With respect to size, select a container with a width about two-thirds of the height of the tree, if your bonsai is placed on its own. In case you are using a group of plants, the dish should have a width about two-thirds the height of the tallest plant. Finally you should develop your own sense of taste and feeling for shape. (Fig. 25)

As the shoot is bent

A bonsai is a plant that has been dwarfed, carefully trained and shaped. It is at this point where the bonsai grower must use his knowledge of plants to control the shape. It is not simply enough to know when and where to prune any more than it is enough just to have "good taste".

An ideal bonsai should have its small branches and twigs wisely pruned and buds and new shoots removed. This has to be carried out frequently if you are to maintain



Fie 25 *Upright and group styles are planted in rectangular or oval containers with main trunk slightly off-centre. The cascade or slanting styles are planted in centre of round of equilateral pots.*

the shape that you have obtained by your hard work. You require two pairs of sharp scissors, one strong and powerful, the other more delicate; and a small saw for thicker branches.

Time to start training bonsai plant

You can start training a bonsai when you are sure that the plant can tolerate various forces. It is normally recommended that graftings, seedlings, and cuttings can be used when they have produced new shoots 5 to 8 cm long. Layerings have many new shoots and leaves.

Gathered plants are already many years old before being placed in bonsai containers. The gathered plants can be trained as soon as they have established in new container. If the foliage does not show signs of drooping or discolouring after placing in the container you can start training.

Pruning

There are two kinds of pruning on your bonsai - one is severe pruning, the other is nipping or pinching back.

Pruning is normally just a one-time operation, done on gathered trees or nursery trees (and occassionally on established bonsai when damage or disease creates a need for changing the basic structure). Pruning establishes the basic shape of plant by removing unnecessary and unsightly branches. Therefore, you must study the growth pattern of the tree in nature. Now you should decide which branches should be removed, when you are resorting to drastic pruning, you should see the health of the tree and the possibility of leaving scars. You should not start pruning if you find that your tree is weak. Drastic pruning can be enough to kill an unhealthy plant. At the same time you should also remember about the best time of the season when drastic pruning can be done. (Fig. 26 & 27)

1. During drastic pruning you should prevent or at least reduce scarring. This can be done by leaving the

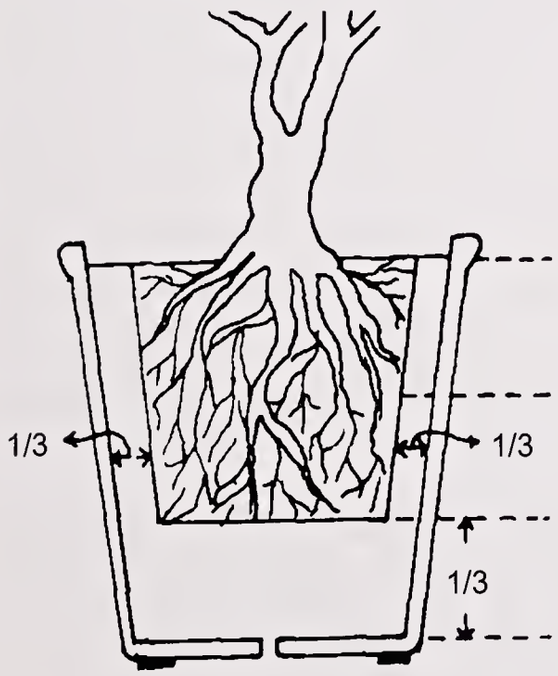


Fig. 26 *When root pruning a bonsai from the pot, one third of the volume, roots and compost is taken away. The ball of the remaining two-third is again planted.*

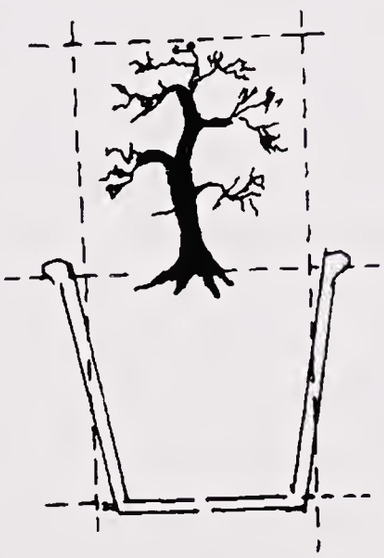


Fig. 27 *The container may hold at least as much soil as the total volume of the tree. It is advisable if the roots are given double the room.*

pruned wood with a concave surface. You can use a trimmer to cut off the branch as close to flush as possible. Now you should use a small chisel and cut off more wood until the surface is concave or at least flush. New bark can grow, rolling over the cut area and most often blending evenly with the old bark. If the surface is not concave, the area can rot or a ugly patch of dead wood will be always visible.

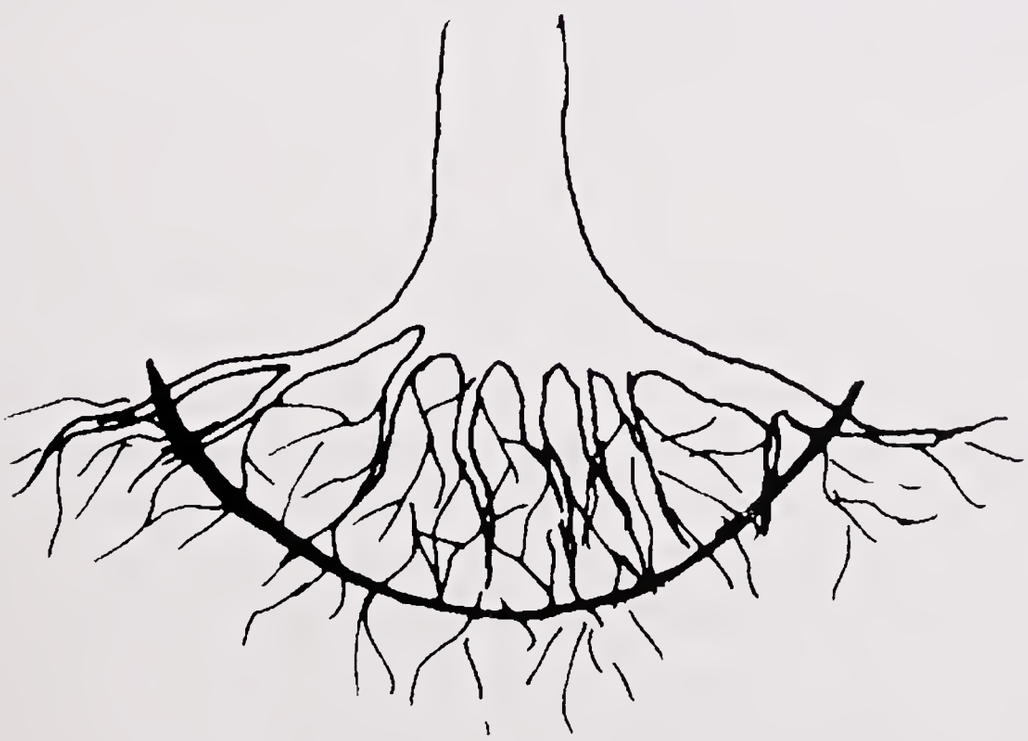
2. when you are trimming a large branch, you should leave a "heel" of bark from under portion of the branch. The length of the heel should match the diameter of the branch being removed. Now you can cut the branch off flush or a little concave; then cover the cut with the heel. It can be tied in place with raffia until the cut heals.

Pinching back is a method of controlling new growth. The purpose is to see that the growth does not become woody. A woody growth always demands severe pruning. Pinching back does not leave any scars. Unlike severe pruning which is normally a one-time operation, pinching back is done quite frequently. It is this method that provides you a graceful control over the size and shape of the plant. Pinching back makes a twiggy tree more dense. Nipping the terminal buds on a branch always forces many side branches to grow. It is nipping that produces a bushy growth. (Fig. 28)

Proper pinching back actually controls the direction of the growth also. Leave all buds that point in the direction you desire new growth. In this process you must remove all others. As a matter of fact you should pinch back all inward growing buds. The inward growing buds can make your plant too bushy and unbalanced. Therefore, you must leave some outside ones that produce the desired shape of the plant. The bottom should remain clean with no downward growing shoots.

Prunting

Removing the tap root *Pruning the main shot* *Pruning the branches*



Pruning the root (Fig. 28)

Pinching back can be done with your fingers or with tweezers. You should not touch any other new growths. This kind of careful attitude is necessary, because new growth is injured very easily and also dies quickly.

You can pinch your tree back any time when growth is taking place. The mango and citrus plants are examples of this kind. Pinch back flowering trees and fruit trees right after they have flowered. On apple and pears tiny spurs appear on the trunk or along heavy branches. These tiny surps can be rubbed off with your fingers. If you are removing them late, an unsightly scar will be visible.

Age cannot whither

We should try to shake loose the notion that a bonsai has to be old to be good. A bonsai may very well be 200 years old, but this doesn't mean that the plant has been under cultivation all that time. True, there may be some bonsai that are in constant training for 1 or 2 centuries and are very valuable treasures. Very old bonsai may have spent the greater part of their life in the forest, growing in a natural environment before you have collected and trained them in your pot.

Actual age is not what is important in bonsai-apparent age is. The valued charateristics of great age need not be natural. Bonsai is an art. In this art, human hand is at work. The human hand causes a tree just in a few year's time to look 50 years old.

There are methods to create the appearance of age - peeling off bark from trunk, branches or exposed roots to make dead wood or scarring and hollowing the trunk.

The art of 'jin' is a technique which gives the trunk, or part of it, or a branch the appearance of dead wood, gnarled and smoothed by the passage of time. You should take a special scalpel (a jin scalpel), or a very sharp grafting knife. Now peel back a strip of bark and rub the wood with very fine grade sandpaper to polish it nicely.

Then take dilute citric acid and treat it, making sure that it does not enter the wood too deeply as it could harm the growing part of the bark. This treatment can quickly bleach the wood, providing it an old seasoned appearance.

The jin technique is particularly good for juniper and pine. When trunk and branches are treated in this fashion, it is called as 'shari' and when the technique is taken further still, to the point where the trunk is literally hollowed out, the method is called as 'sabamiki'. A bonsai grower may feel that the tree is being manhandled, but all trees treated in this manner remain healthy.

The bark is not a living organ of the tree but a protective covering. However, a part must always be left on as the combium layer and the tissues carrying water and nutrients must be allowed to perform their function if the tree is to continue to grow nicely.

Artificial ageing

A tree gets its beauty and shape with age. There are bonsai training methods which enable a tree to look older than it is, and at the same time correct any defects in its shape.

Jin

The method of jinning includes leaving branches of the tree that have broken off or died back in natural way. You can strip away the bark from the branches and sharpen their ends a litte if you desire. Smooth along the entire length of the branch with emery paper before painting with citric acid or wood bleaching agent which in turn bleeches the branch. It protects the branch from rot.

You can use jinning in tall trees. These trees can appear shorter if you simply cut off the leaves or needles at the tip of the tree. You should also remove the bark that

is exposed. Now you should proceed as stated above. All conifers and some broad-leaved plants are very good material for jinning.

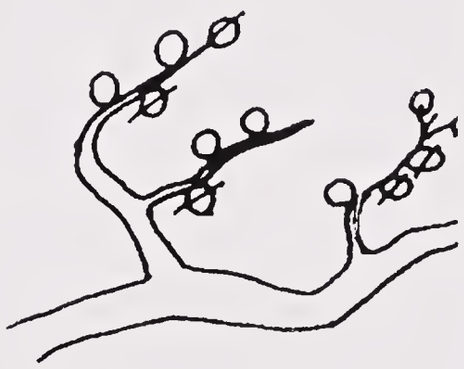
You can also partially strip the bark from branches or trunks and many times even from a clearly prominent visible thick root. By this process the tree gets a beautiful appearance. Working from the top downwards, you should peel a narrow strip of bark from the front of your tree, having previously loosened the strip by making two vertical cuts with a very sharp knife. Now you can use emery paper to smooth the wood down. You can also use citric acid or a wood bleaching chemical. But this has to be done carefully so that the chemical bleaches only the areas of the tree stripped of bark.

In another method you can create hollowness in a trunk. It is a wood-splitting method. When you do this you should copy the shapes of trees found in nature, particularly among old banyan trees. In case you are having a bonsai with a damaged trunk, in which case you can take a chisel and hollow it out at the damaged spot. You should treat this area as has been stated for jinning. You can also rip out a forward-growing branch by using a chisel. The hole can be enlarged in the trunk. This also gives an old age effect into your bonsai. You should carry out all these techniques when the growth is taking place. At this time the bleaching chemicals can soak nicely into the trunk. The wounds can also dry quickly. You must remember to use a sharp knife and smooth the wood down with emery paper before applying the bleaching chemical. You must reapply the bleaching chemical at least every two years to check rot taking place in the stripped branches. This also re-emphasises light colour. Besides these techniques there is another method of making your tree appear older. In this method you can simply tie the branches down or wire them so that their outline resembles those of the older trees in nature.

Leaf pruning

Every bonsai grower must ensure the size of the leaves, branches and trunk are in proportion with each other. With a small-leaved bonsai the proportions are right anyway but with other plants large leaves can be obtrusive. Leaves can be made smaller in many ways. Once the leaves have emerged and opened out completely, you should remove them with some leaf cutters or a pair of scissors. You should ensure that your tree is healthy. (Fig. 29 & 30)

Fig. 29 *(a) Be careful in pinching–do not harm other growth..*



(b) The growth is controlled by pinching all the buds except those that point upwards.

Leaf cutting is actually defoliation of a tree. By removing all the leaves, you produce an artificial leaf-drop season. Soon after, new growth begins to appear.

Fig. 30 *Leal cutting requires removal of entire leaf. Only stem should remain.*

Thus you squeeze two growing periods into one. On young plants, leaf cutting speeds up growth but doesn't markedly decrease leaf size. On older trees, size of leaf may be

significantly reduced by leaf cutting. The correct time for leaf cutting is when growth is taking place actively. You can do it early in spring when new growth starts. You should not do it towards the end of the year in temperate and sub tropical climate because the new shoots and leaves will mature too late. In this way your tree may be unable to stop its growth activity well in advance in cool winter, thus making it particularly susceptible to frost, if your bonsai are kept outdoor. Correctly timed leaf cutting also enhances the colour in autumn. You should also do leaf pruning if the crown of the tree has become too thick. The presence of many leaves keep away much of the sunlight from the inner portion of the plant. It also interferes with the circulation of air, particularly for the lower branches of your bonsai. This is why you should pinch out largest leaves. If you do like this the crown will not become too dense.

You should not provide fertiliser to your tree right before or after leaf cutting. You may cut the leaves removing the entire leaf but leaving the petiole. If any portion of the leaf is left on, the tree will spend its food on it. This energy may not be available for making new leaves. The new leaves should begin to appear after a month or more when the old ones have been removed. It depends on the kind of plant and the season in which leaf cutting has been done. Until new leaf buds appear, keep the plant in a shady area. Because leaves have been removed, there will be less loss of water from transpiration. Therefore, you may provide less watering than normal.

Thickening trunk and branches

Many times you may find that the trunk of a bonsai appears too thin in relation to the crown. In this case you can very easily thicken it. It is the lower branches that determine the thickness of a trunk, so cut them away only when the trunk is as thick as you desire. In case you want

to thicken only the base of the trunk, you may wrap a piece of aluminium wire round the trunk just below the surface of the soil. By this method the trunk will thicken by swelling relatively quickly. You should remember to remove the wire after 8 to 10 months. It may be in the same year or so as the case may be. In case you do not remove the aluminium wire, it may constrict the tree or the wire may penetrate inside the trunk too much and cause the death of the plant.

When you want to thicken a branch that looks too thin, you may allow all shoots and leaves to grow fully. A branch obtains more food if it has more foliage. Therefore, the girth of the branch increases because it is getting greater amount of nutrition.

Fine control of form

It is the wiring and bending of branches that gives form and shape to a plant. The act of wiring and bending is unique to bonsai. Wiring can make a young tree look old by turning branches downward. It can also turn an upright tree into a cascade or semi cascade. You can also produce a curve to a straight trunk or make a new apex out of a strong branch. You should be very careful when you are doing wiring because it is usually done after a tree has been thinned and the branches that are left are crucial to the design that you are following. The best way to learn the technique of wiring is to try it many times with a large, fairly limber branch pruned from a garden tree.

Wiring

In general, deciduous trees are wired when they are actively growing. At this stage the leaves are of full size but the branches are still easily bent. You should wire evergreens on a similar principle. Many plants are less brittle when dormant, they should be wired at this time.

You should not wire plants in the budding season. Because the young buds are likely to be damaged. (Fig. 31 & 32)

Kinds of wire

Two kinds of wires are good for bonsai. Traditionally, the bonsai experts used copper wire. But aluminium wire with a dull finish are also easily available. This kind of wire is suitable for bonsai. It is flexible, easy to bend. It also holds bends nicely and doesn't rust. The size of the wire depends on the thickness of the branch or trunk to be wired. Number 8 wire is quite heavy and may be used only for a trunk because it puts too much weight on a branch. Number 16 and smaller are light. They are suitable for very thin branches or for tying rather than bending. For bonsai work, copper wire is frequently annealed to make it more flexible. You may anneal by putting the bare wire in a hot fire obtained with wheat straw. You can also use old newspapers, In this case you can put the wire in tightly wrapped newspapers. Now you can burn the newspapers and after the flames have cooled remove the wire and let it cool. You should not bend it immediately.

There is a general rule about the thickness of a wire. The wire should be about 1/3 the thickness of the branch at its thickest point. The length of a wire to be used should be about half as long as the branch to be wired.

You should observe the branch after wiring. If the branch has followed its path as you wanted, you can remove the wire. This wire can be reused. Now you should straighten out the twists and bends. The branch should be flattened by tapping it with a mallet. It is necessary to let a plant go without irrigation for a day or so. This will make the branches more limber and convenient to bend. You should not particularly irrigate the deciduous trees. The branches of these plants can

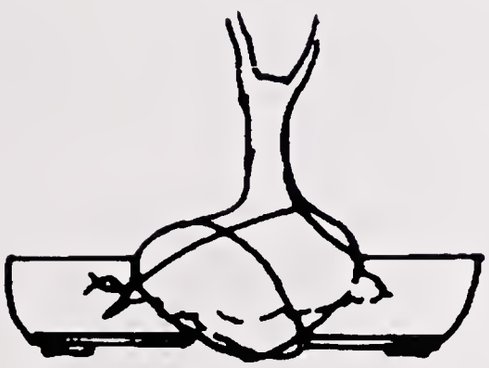


Fig. 31 *The top heavy tree is anchored with wire using drain holes.*

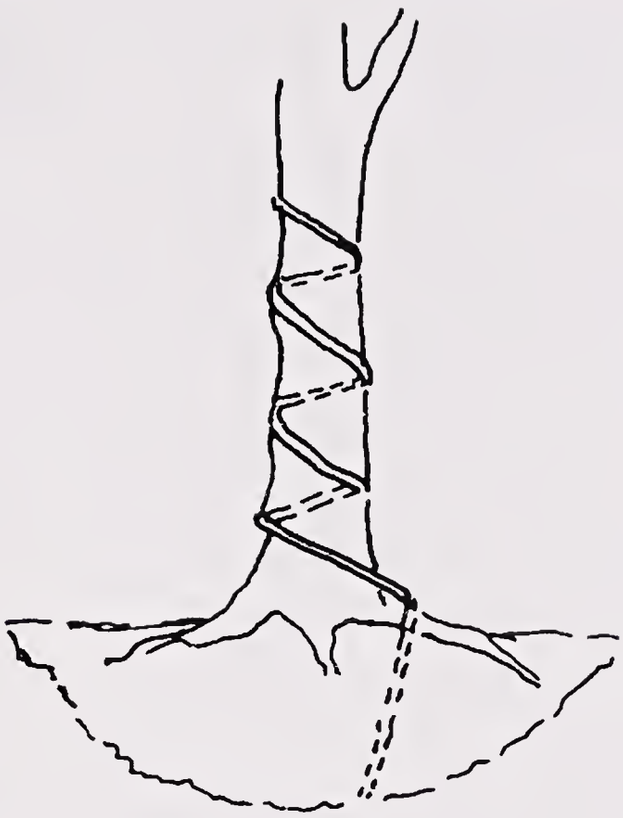


Fig. 32 *The wiring is started from the lowest point on tree and goes upward and outward. Here the wire is anchored in the soil of the pot.*

break more easily when you are bending them. It is also necessary to keep ready proper guages and lengths of wire ready. Side by side you should study the parts of the tree you will bend and how you want to wire them. You should also be very careful in bending the branches. The bending should be done slowly until they take the shape you want them to. If you find that a branch is not bending in the way you desire it, you can make a small cut at a point where the branch joins the trunk. By this method a branch can be made to bend. You should not wire shoots that are less than 5 cm long because they are very tender and too easy to damage. If you find your tree soft-barked, you should wrap the wire with paper.

Technique of wiring

When you want to wire the trunk, anchor the end of the wire in the soil, placing it down to the bottom of the container. You should do this at the back of the trunk, so that the wire is not clearly visible. Wire diagonally clockwise or counter-clockwise and wrap the wire in 45° turns, keeping a uniform distance between bands. You should keep the winding snug but not too tight. In case the wire is very loose, the trunk or branch will not hold a bend. On the other hand if the wiring is too tight, the wire may enter into the bark, thus damaging it. You should also remember that the wire will tighten when you are bending the trunk or branch. It is also possible to continue without cutting the wire if the branches are large, when you are moving from wiring the trunk to wiring branches. It is also

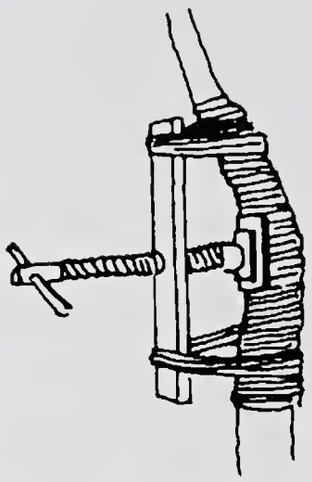


Fig. 33 *A screw-clamp is used to provide a well-defined curve to a trunk*

Fig. 34 *To bring a pair of trunks nearer, bend a small piece of wire into an 'S' shape. After some time you can remove the 'S' and the branches will stay in their new location*

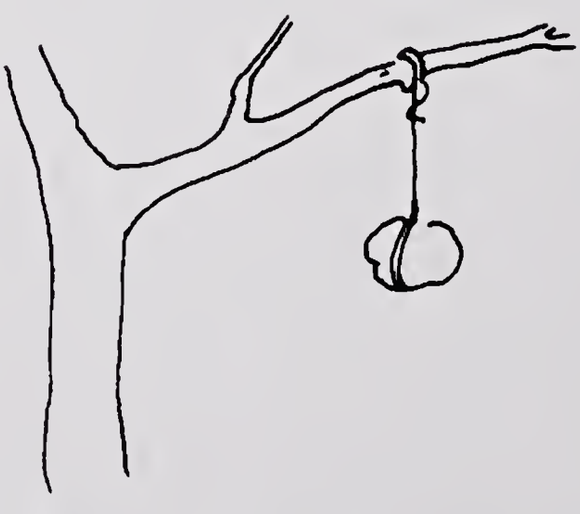


Fig. 35 *A branch can be brought down by using a weight.*

Fig. 36 *Small shoots coming down are removed before writing.*

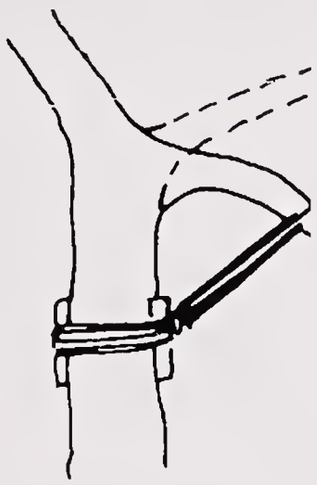


Fig. 37 *A branch that is quite stiff for bending by wiring can be bent by tying. In tying or propping, don't force a branch into its new position all at once. Do it slowly.*

possible to finish off and start again with smaller wire in this case. The end of a wire must blend in with the trunk or branch-placed at the back as far as possible. Now you may cut it off and press the end close against the bark so it doesn't stick out.

You should begin wiring from the lowest point. It does not matter whether it-is on the trunk or a main branch. You should start from the heaviest branches coming towards the lightest ones. It is also advisable to begin at the junction of the branch and trunk or at a major branch fork and secure the wire by wrapping it around the trunk or branch. Remember to face the end of the branch you are wiring. It is also quite important not to bend or break leaves, small shoots, or branches. It is also recommended to use a double strand of wire for providing additional strength. You should never use crisscross wires.

You should be careful to begin bending the branch in the direction you desire it to go, in relation to the final bend. After wiring a branch properly, you can now bend it in a shape that your want

As stated above you should decide in the beginning the form you want the branch to follow. Once you have

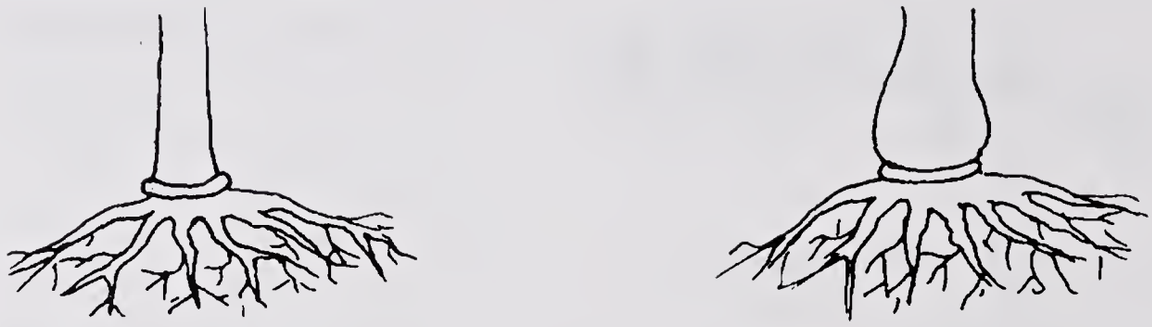


Fig. 38 *Wiring the base of the trunk. The objective is to artificially thicken the trunk (see left). Do not make the wiring too strong & tight. (See right)*

placed a bend in a branch, don't make efforts to straighten it or bend it in a different direction. If you do so there are chances of weakening the wood greatly. It may also break or split. Keep both thumbs together on the inner side of the bend and hold the branch strongly. You should not place a section of wire right inside a bend. The bend does not have much holding power at this point. The bends should be made quite gradual. You should not make any sharp angles.

Many times a branch may snap,

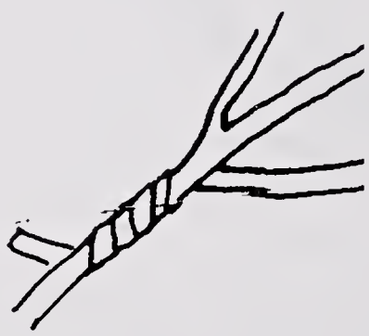


Fig. 39 *The very tender bark is protected by wrapping wire with paper.*

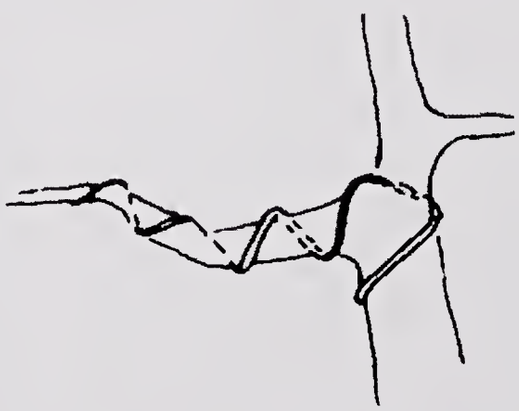


Fig. 40 *Make each turn 45", keeping uniform distance between bands, Cut where the branch meets the trunk, helps bend branch.*

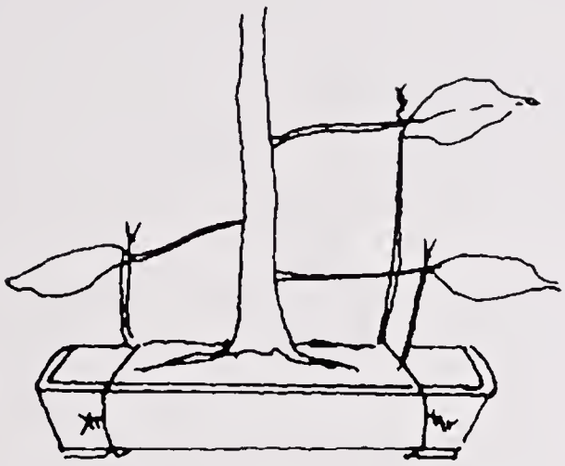


Fig. 41 *Many branches can be pulled downward to give a weeping appearance. The "wires are secured to the trunk, to the container or to the exposed thick roots if possible.*

inspite of your careful efforts. The persimmon- a fruit plant is very much susceptible to snap. If a branch splits, you can save it to a great extent. You can bring broken pieces of the branch together in an exact manner. Now wrap the break with raffia or with polythene tape and tie it up. The broken part like a fracture in the human bone may heal in a few months. But many times a branch may snap off completely. In this case you cannot do much except pruning it.

In shaping wired shoots and branches, you should avoid crossing or inermingling them. But many times you need a twist of the branch to one side to help fill a gap. While doing so you should not distort it into an unnatural shape. A ragged, sparse plant may be bent if you find open space for branches to go.

In case by pruning too much wood has been removed, wiring and bending can not be of much use.

Other techniques

Wiring is not only the technique for bonsai training. There are many other effective methods in providing the desired form to a tree. Many times the branches are too strong, stiff and mature. These cannot be bent by wiring. Never knot or twist a wire very strongly onto a branch but make a very loose loop. While doing so protect the wood by placing a small pad under the wire. In tying or

Fig. 42 *To check or atleast minimise scaring due to drastic pruning, always leave the pruned wood with a concave surface. You can use a trimmer to cut off the branch as close to flush as possible. Now you may get a small chisel and cut off more wood until the surface is concave, (b) Leaving the cut lumpy or stubby can make the area prone to rotting or create an ugly patch of dead wood.*

propping these stiff branches, do not force a branch into its new position all at once. This is more important if the change from its original shape is quite radical. If you do so the branch may split or even break. In such a situation you should secure it at 1/3 to 1/2 the full final position. After this wait for a few months and then pull it again slowly a little more. Follow this method till you obtain the shape that you want.

You should take some precautions when you want to remove wires. In case of young trees the wire can be left for few months. The older plants grow much more slowly than young ones.

Fig. 43 *After wiring a branch or a trunk bend it gently in the desired direction.*

In such plants the wire should be left for about a year, but it also again depends on your keen observation. If the wire is left for a long time, the tree's bark may grow around it. This makes it difficlut to remove the wire and also leaves big unsightly scars around the portion where the wire has not been removed in time. When you want to remove a wire you should start from the outermost end of a branch and

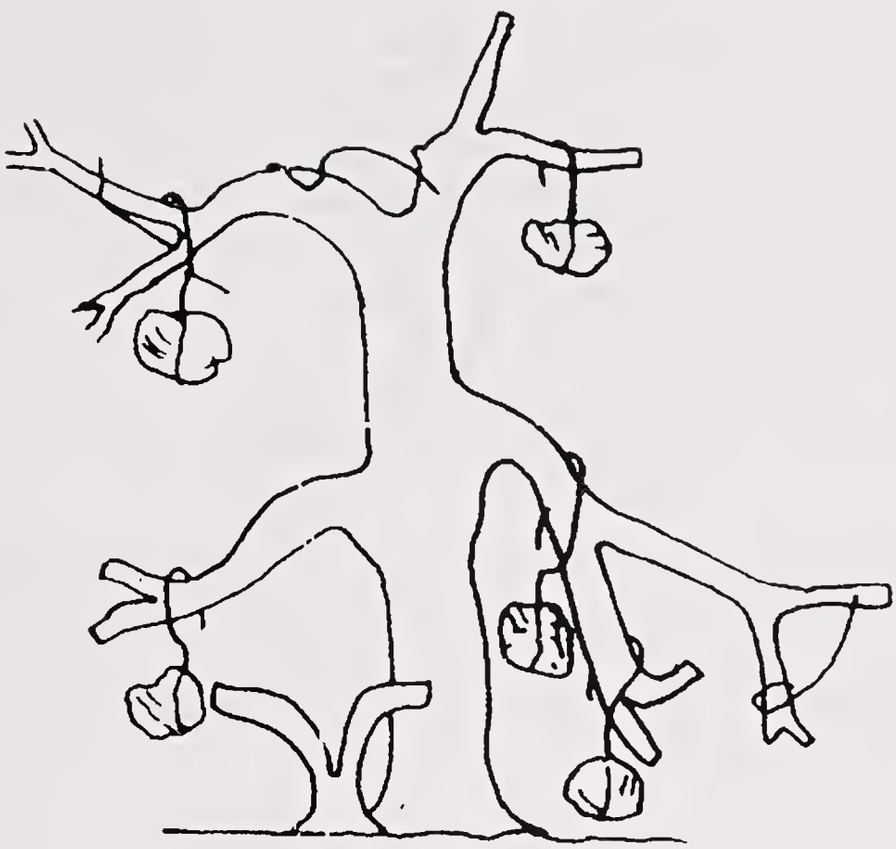


Fig. 44 *Shoots are encouraged to grow downwards in a natural style by the use of weights and wires formed into double-hook separators.*

unwind back towards the anchor end. While doing so be careful not to harm leaves or small growing shoots and branches. Many times the wire may enter into the bark. In this situation do not unwind it. It is quite likely you may tear off unknowingly some part of the bark. It is always better to use a small wire cutter to snip the wire off in very small pieces.

Coming back again to other techniques of training, you may also provide a shape by pulling many branches downward. By this method it is easy to give a weeping appearance. You can do this by running lengths of the wire from each branch to the base of the tree. In this technique the wires are secured to the trunk, to the pot or to the exposed strong thick roots. While doing so again you should use your judgement in selecting the part as mentioned above.

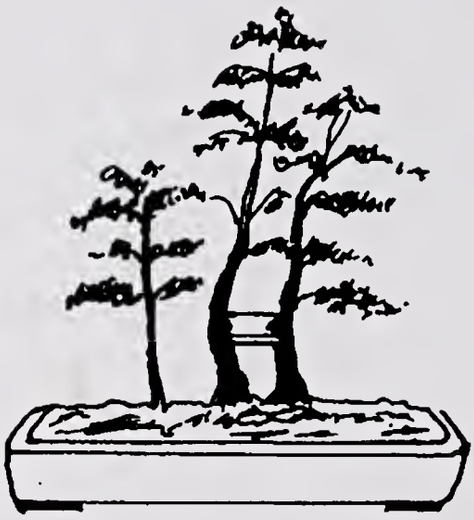


Fig. 45 *Many times the branches or trunks are too close together. In this case, you can prop them apart with a small twig or dowel. Now cut a small notch in each end of the prop and wedge the stick between the two branches to keep them apart. Remove the prop after 4 months.*

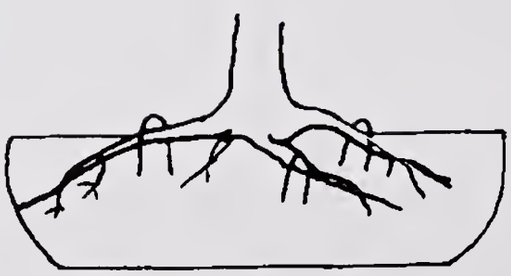


Fig. 46 *Wire clips hold* ***down*** *the roots.*

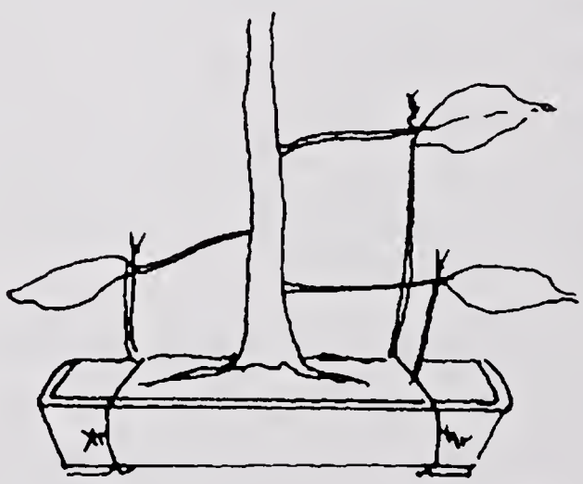


Fig. 47 *Many branches can be pulled downward to give a weeping appearance. The wires are secured to the trunk, to the container, or to the exposed thick roots if possible.*

There is another technique of training branches. It involves the use of weighted string or wire. The branch can be brought down. In this method you should simply attach a weight to a string or wire and affix the other end to the branch you want drawn downward. It is quite important to select a weight of proper size. It can not be very heavy. It may break the branch. It is quite convenient to use stones or iron weights. You can drill a hole so that the string or wire can enter and hold the weight firmly.

It is also quite likely the tree may have a pair of forked branches or two trunks or branches that are quite close to each other. In this situation it may not be possible to use a wire. But you can prop apart with a small twig or dowel. Cut a small notch in each end of the prop and wedge a stick between the two branches. This may force them apart. You may remove the prop after some months. It depends again on your judgement. There is a possibility that the branches may come back to their original positions. Now you should again place the prop back. After sometime the plant parts loose their habit to spring back when the prop is removed. Many times you may need the training of a pair of branches or trunks to come close. Bend a small piece of wire into an "S" form. You should hook each branch into one of the curves of the "S" to draw the two together. In course of time the "S" can be removed. The branches stay in their new position. But when you want to change the shape of a heavy trunk, wiring is not enough. Special bonsai jacks are available which can change the shape of big trunks.

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PEST AND DISEASE MANAGEMENT

Insects

An insect is an anthropod with a three-part body and six legs. Insects are the most abundant types of anthropods with several hundred thousand different species, most of which are neutral or beneficial for bonsai gardens and other crops. For example, insects are extremely important in pollination, but pesticides have inadvertently killed many pollinators. Numerous crops are suffering from lack of pollination. Honeybees (*Apis mellifera*) are probably the most important pollinators along with bumblebees (*Bombus spp*), Leaf-cutting bees (*Megachile Spp*), mason bees (*Osmia spp*), Honeybees and *flies* are the main pollinators in the tropics.

Insects can cause damage in the bonsai plants by chewing leaves, stems, flowers, fruits and roots. Ants are a common bonsai plant pest worldwide and can cut down young seedlings, damage tree bark, or cut and carry away parts of leaves from mature bonsai plants. Bonsai growers must protect seeds and young seedling from ants. Ants are difficult to control because their nests can be several feet underground. Some common methods like citrus oil can be used. Citrus oil is toxic to ants and fresh, mashed citrus peels may help repel them, as will garlic. The bonsai grower can also try to slow the ants down, discouraging them from doing any major damage by pouring boiling water into their holes.

Grasshoppers may also chew the parts of plants. Sprays made with hot chilli peppers and soap may help repel them when there are in large numbers. Caterpillars are the larvae, or immature forms, of moths and butterflies, and many of them chew leaves, stems and fruits. Cutworms are the caterpillars of various moths.

Sucking insect pests have piercing mouth parts which they use to penetrate plant cells and suck out the contents. Sucking insects include whiteflies, aphids, scale insects, thrips, plant hoppers and leaf or plant bugs. They may carry and spread bacteria and/or viruses that may cause disease. Many mites may also damage plants this way. Some other sucking insects and predatory mites may also kill pests in the garden and are thus beneficial. Common signs of damage by sucking insects are leaves that are curled, twisted, or have dry spots, and abnormal looking twigs. Tapping the plant to dislodge mites and small insects onto a cloth or other clean surface makes them easier to see as they crawl for escape. If a hand lens or magnifying glass is used, it becomes easy to identify. Larger ones can be controlled by hand-picking, smaller ones by crushing, washing them off the plants with water, or spraying with soap or other home mixtures. (Fig. 48 & 49)

Fig. 48 *Aphid (Greenfly)* *Caterpillar*

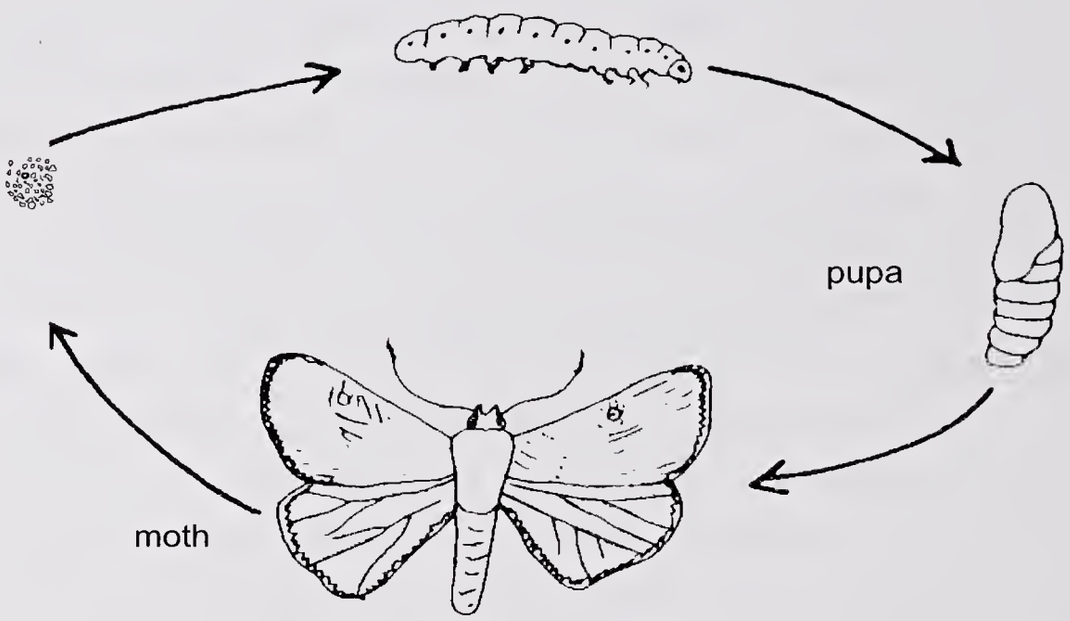


Fig. 49 *Life cycle of an insect*

Boring insects make holes in stems, roots, and fruits and do most of their damage from the inside. Often a small hole and perhaps some frass is the only evidence on the outside. Fly larvae (maggots), adult beetles and grubs and caterpillars are among the most common boring insects.

Nematodes are roundworms, of which there are several thousand species. Most live freely in the soil and feed on roots. Most nematodes that attack plants are microscopic and live under ground where they feed on roots as stated above. Some feed on flowers, seeds,and leaves. They also spread viral diseases and interact with some disease-causing fungi and bacteria, causing damage to plants greater than the sum of each separately. The nematodes that live inside roots cause root galls, root lesions and excessive branching. They also injure the roots and make them rot. The above ground symptoms are chlorosis (yellowing) of the whole leaf, wilt, failure to thrive and poor yield. The most common example of this category is the root knot nematode *(Meloidogyne spp.)*. This nematode causes knots or galls on the root. Nematode problems can be managed using a number of chemicals. (Fig. 50)

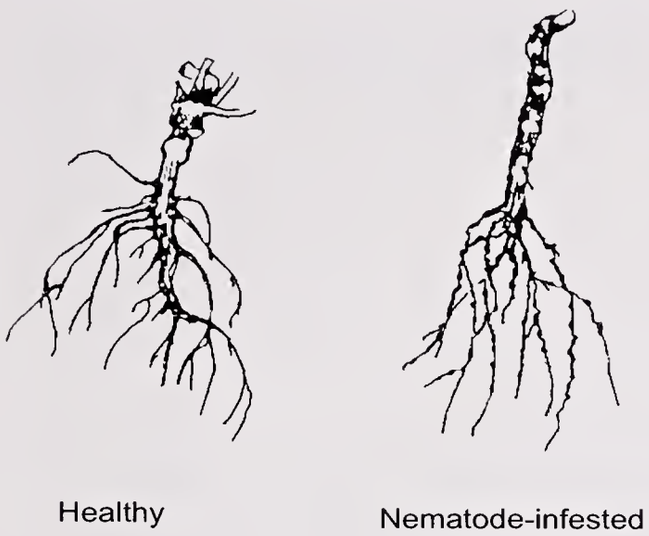


Fig. 50 *Nematodes on roots*

Diseases

In bonsai plants, disease is abnormal growth or functioning that harms the plant. Disease can be infectious or non-infectious. Examples of non-infectious diseases are nutritional deficiencies, sunburn, and severe drought stress. Diseases can largely be identified by plant pathologists (specialists in the study of plant diseases) using specialised equipment and processes, and even they are not always successful.

Fungal, bacterial, and viral pathogens are quite imporant in this category. Fungi (the singular is fungus) are nonphotosynthesizing organisms that obtain their food through the decomposition of organic matter or from living organisms. Bacteria are very small (0.001 - 0.003 mm). Some of the bacteria live only as parasites in plants. Fungal and bacterial diseases often appear first on lower stems, trunks, fruit, and older leaves near the soil surface. On leaves they show up as specks or spots that are water-soaked, dark green or brown. Lesions may look like a target, having alternating dark and light concentric circles or may have a furry, moldy appearance. The fruit may feel like a bag of water, look rotten and moldy, or have a scab like wound, depending on the disease.

A virus is a parasite that can only reproduce by invading and taking over cells of other organisms. In plants viruses are spread mainly by infected seeds, cuttings, grafts; and by sucking insects or people touching infected plants and then uninfected plants. Viruses cannot live without a host nor can they lie dormant in unused

soil. Viruses harm their hosts by diverting the resources and processes of those cells into the production of more viruses. In plants there are viral diseases that affect only specific crops and others with a wide range of hosts. Often, viral symptoms in plants are most obvious on new growths as deformities, dieback, and discolouration.The plant diseases caused by viruses are almost always systemic.

Distinghishing between systemic and localized plant diseases can help bonsai growers plan their disease control programme. Localized diseases are only active in certain parts of the plant such as the roots or leaves and fruits. Systemic diseases, including vascular wits and almost all viral diseases, are spread throughout the plant. Some localized diseases or pest problems, especially in the roots, may first become evident to the bonsai grower in symptoms that look systemic like wilting . Checking the roots of bonsai plant helps detect these problems early, before they cause too much damage.

Synthetic pesticides

There are numerous pesticides available in the market. Contact poisons are absorbed through the body surface while stomach poisons have to be ingested by the insect and systemic poisons are first absorbed into the plant tissues before being eaten by the pest or affecting the pathogen.

Organochlorines e.g., Aldrin (Aldrex), BHC, Lindane, Chlordane, DDT, Dieldrin (Dieldrex), Endrin (Hexadrin), Endosulfan are used primarily as insecticides, but some are also used as herbicides (weed killers) and fungicides. They are contact and stomach poisons. Organochlorines are soluble in water and fat, and persist in the environment. They are effective pesticides because they can be disolved in water to make a spray which is then absorbed through insects' exoskeletons, and remains

Serissa foetitda

Commiphora wightii

active for a long time. These characteristics make organochlorines extremely dangerous since they accumulate in the body fat of vertebrates (birds, mammals, including humans).

Organophosphates (e.g. ,Azodrin, Diazinon, Malathion, Methyparathion, Parathion) are used as contact and systemic insecticides and acaricides (chemcials toxic to mites). They have replaced organochlorines for many uses because they break down relatively quickly. Organophosphates interfere with nerve transmission.

N-Methyl carbamates e.g., Aldicarb (Temik), Carbaryl (Sevin), Carbofuran (Furadan), Methiocarb, Propoxur (Baygon) are used as insecticides and nemati-cides (nematode poisons). These pesticides are not as dangerous, except for Aldicarb, which is extremely toxic.

Dithiocarbamates e.g., Thiram, Ziram, Ferbam, Vapam, Maneb, Zineb are used as fungicides.

Inga dulcis
(Driftwood)

Nitrophenols or substituted phenols, e.g., dinoseb, DNOC (Sinox), Pentachlorophenol (Dowicide) are used primarily as herbicides and fungicides, but also as insecticides and acaricides. These chemicals are easily absorbed through the skin.

Pthalamides e.g., Captan, Captafol, Folpet are fungicides very irritating to the skin.

Pyrethroids e.g., Bioallethrin (D-Trans), Cypermethrin (Cymbush, Ripcord), Perethrin (Ambush, Kalfil), Pyrethrins (Pyrethrum), Resmethrin (Chryson, Synthrin) were originally extracted from pyrethrum flowers (Chryanthemum cinerariaefolium) and are powerful contact insecticides that quickly break down in sunlight. A number of synthetic pyrethrins have been developed that have higher toxicity and last longer.

Ficus benjamina

When you are purchasing a pack of insecticide or fungicides, you may find that concentration of the stock solution is mentioned as E.C. (Emulsion Concentrate) 30% or so. Now if you want to prepare a solution containing 0.1%, you can do it by dividing E.C. 30% with 0.1%. It comes to a ratio of 1:300. This means you are required to take 300 parts of water and one part of chemical of the stock solution. This is the diluted spray that can be used on your plants.

Safe home-made pesticides

Some safe ingredients considered to be useful for controlling garden pests are given below. While very little scientific work has been done to find out how these ingredients work, many gardeners find that they are often

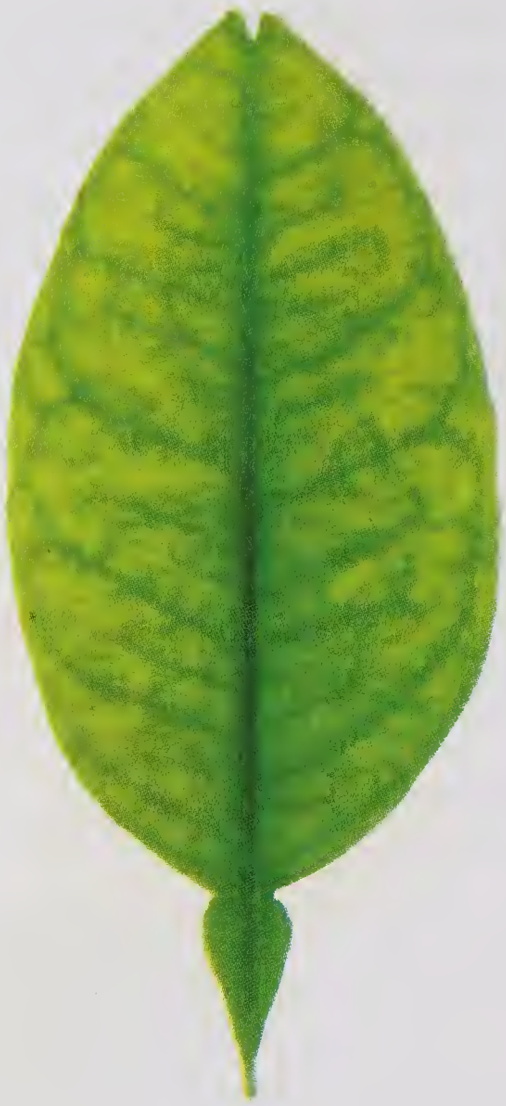
Araucaria
4 years (slanting)

effective. The best solution is to experiment, trying them first on few plants to determine if they have any positive or negative effect.

There are several common formulations which can be made at home to control pests :

1. One part of lead arsenate powder mixed with eight parts of slaked lime powder makes a good dust. Two grams of this mixture can be mixed in a litre of water to make a spray solution for controlling insects that cut or chew the leaves.
2. 125 gm of paris green may be mixed with four kg of bran, a little jaggery and two litres of water. This can be used as poison bait for cut worms and caterpillars.
3. One part of cryolite may be mixed with three parts of talc. This should be sprayed as a dust, killing beetles and weevils.
4. One part of 40% nicotine sulphate may be diluted in 1000 parts of water for use against aphids, thrips, jassids and other soft bodied insects. Five parts of soft soap may also be added to this spray solution. These insects can also be controlled by the spray of tobacco decoction prepared by soaking about 500 gm of tobacco waste in five litres of water for 24 hours. It is then boiled for about an hour. A tobacco decoction is obtained by filtering the above solution. The filterate is diluted eight times before use as spray.
5. 100 gm of resin is boiled in a litre of water in which 50 gm of washing soda has already been dissolved. This solution is diluted eight to ten times with water for spraying against sucking insects.
6. 100 gm of copper sulphate is dissolved in a litre of water in an earthen or wooden vessel. In another non-corroding vessel 100 gm of quick lime is mixed slowly with a litre of water. The strained lime solution is mixed slowly in 100 litres of water. The copper sulphate

Mango leaf
potassium deficiency



Citrus reticulata
zinc deficiency

solution already prepared may be mixed with it. Now add aditional quantity of 2.5 litres of water to this mixture. The liquid mixture is stirred well. Everytime a freshly prepared mixture should be used. It is a very effective fungicide. It is called Bordeaux mixture.

7. 160 gm of lime is dissolved in a small amount of water, to which 160 gm of pure sulphur is added. Volume of solution is made upto 10 litres. The mixture may be filtered before use as a fungicide.
8. *Chrysanthemum coccineum* is a flowering plant cultivated successfully in Kashmir. The flowers of these plants on drying give a powerful insecticide known as pyrethrum. This can be dusted for the

control of leaf hoppers, sucking insects and caterpillars.

Citrus sinensis
iron deficiency

9. Chestnut compound is prepared by mixing two parts of copper sulphate with 11 parts of ammonium carbonate. This mixture should be kept in an air-tight glass jar. One day before use, 30 gm of this mixture is dissolved in 10 litres of water and applied as drench to the soil to free it from fungus infections.
10. *Chili extract*: It is used as a spray to repel insects or slow their feeding. Whole hot (spicy) chili peppers are ground, including the seeds which are a concentrated source of capsaicin, the fiery-hot active chemical in chili sprays. The powdered chillies are left to soak overnight in water. Soap may be added to this mixture. The concentration of this spray can be determined by testing; if too weak it will be ineffective, if too strong it can burn leaves. The strength also depends on the kind of chillies. The spicy content is most important. Care should be taken as this spray can certainly burn the skin and eyes. It is reported to control aphids, caterpillars, beetles and other insect pests.
11. *Neem seed extract*: It is used as a spray to repel insects or slow their feeding; it kills pests when they eat it. Seeds of fruits dropped from the tree are collected, cleaned, dried, and stored in a dry, airy place. When

required, seed hulls are removed and the seeds are finely powdered and hung in cloth bag in a pot of water using between 40-50 gm seed in a litre of water. The powdered seeds are soaked for twenty four hours in water before they are used. This mixture should be made fresh for each use. It may lose its effectiveness over a time and with exposure to sunlight. It is reported to control caterpillars, beetles, grasshoppers and other garden pests.

12. *Soap* : It is used as spray to repel insects. 40 cm^3 of fine quality of soap is mixed into 5 litres of water. Some soaps may contrain harsh additives. It is always safe to test the mixture on a few branches to make sure the plants are not harmed. It is reported to control piercing and sucking insects like aphids and thrips.

13. *Garlic extract* : It is used as a spray to repel insects. 120 gm crushed or grated garlic is soaked for 30 hours in 15 gm of oil. It is then mixed in 0.5 litre water. In this mixture 15 gm of soap is also added. When ready to use add about 18 litres of water to this mixture. It is reported to control aphids and some caterpillars and bettles.

●

JUDGING BONSAI

Since the plant is the centre piece of your interest the following classification is given for the use of judges.

	Max. No. of Points
• Overall appearance as a plant	20
• Extent of harmony between all parts of the frame work (trunk, branches, twigs)	20
• Extent of leaf dwarfing	20
• Extent of artistry obtained between lines and spacing	20
Supplementary points	
• Extent of harmony between the pot and the plant or the effect of the pot as a complementary or dramatising presentation	4
• Natural or artistic touch about the underplanting and landscaping	4
• Presentation of the root formation (exposed roots, roots clasping a stone etc.)	4
• An uncommon species	4
• Extraordinary fine bonsai plant	4
Total	**100**

The book describes in simple and lucid language the techniques of growing Bonsai or miniature trees- a perfect guide for a bonsai lover. It also tells us about various Bonsai styles, the care it deserves, pest and disease management etc.

The author Dr. B.B.Sharma, a former professor of Horticulture, I.A.R.I., New Delhi has a number of books to his credit on Horticulture and Home Gardening.

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